

CITY OF ANN ARBOR
INVITATION TO BID



WWTP HEADWORKS IMPROVEMENT PROJECT

ITB No. 4706

Due Date: January 26, 2022, 2:00PM (Local Time)

WASTEWATER TREATMENT SERVICES UNIT

Issued By:

City of Ann Arbor
Procurement Unit
301 E. Huron Street
Ann Arbor, MI 48104

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City of Ann Arbor Prevailing Wage Declaration Form

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City of Ann Arbor Vendor Conflict of Interest Disclosure Form

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ATTACHMENTS

A Waterman O&M Manual excerpts

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NOTICE OF PRE-BID CONFERENCE AND KEY BID DATES

A pre-bid conference for this project will be held on January 4, 2022 at 10:00 am (local time) at the Ann Arbor WWTP, 49 Old Dixboro Rd, Ann Arbor, MI 48105 with site tour will follow. Bidders shall note that PPE is required for the Tour.

Attendance at this conference is highly recommended. Administrative and technical questions regarding this project will be answered at this time. The pre-bid conference is for information only. Any answers furnished will not be official until verified in writing by the Financial Service Area, Procurement Unit. Answers that change or substantially clarify the bid will be affirmed in an addendum.

KEY BID DATES:

ITB Issued.....	Tuesday, December 14, 2021
Pre-Bid Conference.....	10:00 am Tuesday, January 4, 2022
Optional Site Visit.....	Wednesday, January 5, 2022
Optional Site Visit.....	Thursday, January 6, 2022
Optional Site Visit.....	Tuesday, January 11, 2022
Last date for questions	5:00 pm, Monday, January 17, 2022
Addendum No. 1	Thursday, January 19, 2022
Addendum No. 2 (if required)	Friday, January 21, 2022
Bid Opening	2:00 pm, Wednesday, January 26, 2022

Optional Site Visits are encouraged for all bidders, but participants are required to contact Chris Englert prior to each visit. Visits are confined to 9:00 am to 12:00 pm. PPE is required. Addendum dates are planned and are subject to change.

INSTRUCTIONS TO BIDDERS

General

Work to be done under this Contract is generally described through the detailed specifications and must be completed fully in accordance with the contract documents. All work to be done under this Contract is located in or near the City of Ann Arbor.

Any Bid which does not conform fully to these instructions may be rejected.

Preparation of Bids

Bids should be prepared providing a straight-forward, concise description of the Bidder's ability to meet the requirements of the ITB. Bids shall be written in ink or typewritten. No erasures are permitted. Mistakes may be crossed out and corrected and must be initialed and dated in ink by the person signing the Bid.

Bids must be submitted on the "Bid Forms" provided with each blank properly filled in. If forms are not fully completed it may disqualify the bid. No alternative bid will be considered unless alternative bids are specifically requested. If alternatives are requested, any deviation from the specification must be fully described, in detail on the "Alternate" section of Bid form.

Each person signing the Bid certifies that he/she is the person in the Bidder's firm/organization responsible for the decision as to the fees being offered in the Bid and has not and will not participated in any action contrary to the terms of this provision.

Questions or Clarifications / Designated City Contacts

All questions regarding this ITB shall be submitted via email. Emailed questions and inquires will be accepted from any and all prospective Bidders in accordance with the terms and conditions of the ITB.

All questions shall be due on or before **January 17, 2022, 5:00 pm** and should be addressed as follows:

Specification/Scope of Work questions emailed to **cenglert@a2gov.org**
Bid Process and Compliance questions emailed to **cspencer@a2gov.org**

Any error, omissions or discrepancies in the specification discovered by a prospective contractor and/or service provider shall be brought to the attention of Chris Englert, WWT Services Engineer at **cenglert@a2gov.org** after discovery as possible. Further, the contractor and/or service provide shall not be allowed to take advantage of errors, omissions or discrepancies in the specifications.

Addenda

If it becomes necessary to revise any part of the ITB, notice of the Addendum will be posted to Michigan Inter-governmental Trade Network (MITN) www.mitn.info and/or City of Ann Arbor web site www.A2gov.org for all parties to download.

Each Bidder must in its Bid, to avoid any miscommunications, acknowledge all addenda which it has received; but the failure of a Bidder to receive, or acknowledge receipt of; any addenda shall

not relieve the Bidder of the responsibility for complying with the terms thereof.

The City will not be bound by oral responses to inquiries or written responses other than written addenda.

Bid Submission

All Bids are due and must be delivered to the City of Ann Arbor Procurement Unit on or before **January 26, 2022 by 2:00pm (local time)**. Bids submitted late or via oral, telephonic, telegraphic, electronic mail or facsimile **will not** be considered or accepted.

Each Bidder must submit one (1) original Bid and two (2) Bid copies in a sealed envelope clearly marked: **ITB No. 4706 – WWTP Headworks Improvement Project**.

Bids must be addressed and delivered to:

City of Ann Arbor
Procurement Unit,
c/o Customer Services, 1st Floor
301 East Huron Street
Ann Arbor, MI 48104

All Bids received on or before the Due Date will be publicly opened and recorded immediately. No immediate decisions are rendered.

The following forms provided within this ITB Document should be included in submitted bids.

- **City of Ann Arbor Prevailing Wage Declaration of Compliance**
- **City of Ann Arbor Living Wage Ordinance Declaration of Compliance**
- **Vendor Conflict of Interest Disclosure Form**
- **City of Ann Arbor Non-Discrimination Ordinance Declaration of Compliance**

Bids that fail to provide these forms listed above upon bid opening may be rejected as non-responsive and may not be considered for award.

Hand delivered bids may be dropped off in the Purchasing drop box located in the Ann Street (north) vestibule/entrance of City Hall which is accessible to the public at all hours. The City will not be liable to any Bidder for any unforeseen circumstances, delivery or postal delays. Postmarking to the Due Date will not substitute for receipt of the Bid. Each Bidder is responsible for submission of their Bid.

Additional time for submission of bids past the stated due date and time will not be granted to a single Bidder; however, additional time may be granted to all Bidders when the City determines in its sole discretion that circumstances warrant it.

Award

The City intends to award a Contract(s) to the lowest responsible Bidder(s). On multi-divisional contracts, separate divisions may be awarded to separate Bidders. The City may also utilize alternatives offered in the Bid Forms, if any, to determine the lowest responsible Bidder on each division, and award multiple divisions to a single Bidder, so that the lowest total cost is achieved for the City. For unit price bids, the Contract will be awarded based upon the unit prices and the

lump sum prices stated by the bidder for the work items specified in the bid documents, with consideration given to any alternates selected by the City. If the City determines that the unit price for any item is materially different for the work item bid than either other bidders or the general market, the City, in its sole discretion, in addition to any other right it may have, may reject the bid as not responsible or non-conforming.

The acceptability of major subcontractors will be considered in determining if a Bidder is responsible. In comparing Bids, the City will give consideration to alternate Bids for items listed in the bid forms. All key staff and subcontractors are subject to the approval by the City.

Official Documents

The City of Ann Arbor officially distributes bid documents from the Procurement Unit or through the Michigan Intergovernmental Trade Network (MITN). Copies of the bid documents obtained from any other source are not Official copies. Addenda and other bid information will only be posted to these official distribution sites. If you obtained City of Ann Arbor Bid documents from other sources, it is recommended that you register on www.MITN.info and obtain an official Bid. Bidders do not need to be shown on the plan holders list provided by MITN to be considered an official plan holder.

Bid Security

Each bid must be accompanied by a certified check, or Bid Bond by a surety licensed and authorized to do business within the State of Michigan, in the amount of 5% of the total of the bid price.

Withdrawal of Bids

After the time of opening, no Bid may be withdrawn for the period of 90 days.

Contract Time

Time is of the essence in the performance of the work under this Contract. The available time for work under this Contract is indicated on page C-2, Article III of the Contract. If these time requirements can not be met, the Bidder must stipulate on Bid Form Section 3 - Time Alternate its schedule for performance of the work. Consideration will be given to time in evaluating bids.

Liquidated Damages

A liquidated damages clause, as given on page C-2, Article III of the Contract, provides that the Contractor shall pay the City as liquidated damages, and not as a penalty, a sum certain per day for each and every day that the Contractor may be in default of completion of the specified work, within the time(s) stated in the Contract, or written extensions.

Liquidated damages clauses, as given in the General Conditions, provide further that the City shall be entitled to impose and recover liquidated damages for breach of the obligations under Chapter 112 of the City Code.

The liquidated damages are for the non-quantifiable aspects of any of the previously identified events and do not cover actual damages that can be shown or quantified nor are they intended to preclude recovery of actual damages in addition to the recovery of liquidated damages.

Human Rights Information

All contractors proposing to do business with the City shall satisfy the contract compliance administrative policy adopted by the City Administrator in accordance with the Section 9:158 of the Ann Arbor City Code. Breach of the obligation not to discriminate as outlined in Section 5, beginning at page GC-2 shall be a material breach of the contract. Contractors are required to post a copy of Ann Arbor's Non-Discrimination Ordinance attached at all work locations where its employees provide services under a contract with the City.

Wage Requirements

Section 4, beginning at page GC-1, outlines the requirements for payment of prevailing wages and for payment of a "living wage" to employees providing service to the City under this contract. The successful bidder and its subcontractors must comply with all applicable requirements and provide proof of compliance.

Pursuant to Resolution R-16-469 all public improvement contractors are subject to prevailing wage and will be required to provide to the City payroll records sufficient to demonstrate compliance with the prevailing wage requirements. Use of the Sample Certified Payroll form provided in the Appendix section or a City-approved equivalent will be required along with wage rate interviews.

For laborers whose wage level are subject to federal, state and/or local prevailing wage law the appropriate Davis-Bacon wage rate classification is identified based upon the work including within this contract. **The wage determination(s) current on the date 10 days before bids are due shall apply to this contract.** The U.S. Department of Labor (DOL) has provided explanations to assist with classification in the following resource link: beta.SAM.gov.

For the purposes of this ITB the Construction Type of Heavy will apply.

Conflict Of Interest Disclosure

The City of Ann Arbor Purchasing Policy requires that prospective Vendors complete a Conflict of Interest Disclosure form. A contract may not be awarded to the selected Vendor unless and until the Procurement Unit and the City Administrator have reviewed the Disclosure form and determined that no conflict exists under applicable federal, state, or local law or administrative regulation. Not every relationship or situation disclosed on the Disclosure Form may be a disqualifying conflict. Depending on applicable law and regulations, some contracts may awarded on the recommendation of the City Administrator after full disclosure, where such action is allowed by law, if demonstrated competitive pricing exists and/or it is determined the award is in the best interest of the City. A copy of the Vendor Conflict of Interest Disclosure Form is attached.

Major Subcontractors

The Bidder shall identify on Bid Form Section 4 each major subcontractor it expects to engage for this Contract if the work to be subcontracted is 15% or more of the bid sum or over \$50,000, whichever is less. The Bidder also shall identify the work to be subcontracted to each major subcontractor. The Bidder shall not change or replace a subcontractor without approval by the City.

Debarment

Submission of a Bid in response to this ITB is certification that the Bidder is not currently debarred,

suspended, proposed for debarment, and declared ineligible or voluntarily excluded from participation in this transaction by any State or Federal departments or agency. Submission is also agreement that the City will be notified of any changes in this status.

Disclosures

After bids are opened, all information in a submitter's bid is subjected to disclosure under the provisions of Michigan Public Act No. 442 of 1976, as amended (MCL 15.231 et seq.) known as the "Freedom of Information Act." The Freedom of Information Act also provides for the complete disclosure of contracts and attachments thereto except where specifically exempted.

Bid Protest

All Bid protests must be in writing and filed with the Purchasing Agent within five (5) business days of the award action. The bidder must clearly state the reasons for the protest. If a bidder contacts a City Service Area/Unit and indicates a desire to protest an award, the Service Area/Unit shall refer the bidder to the Purchasing Agent. The Purchasing Agent will provide the bidder with the appropriate instructions for filing the protest. The protest shall be reviewed by the City Administrator or designee whose decision shall be final.

Any inquiries or requests regarding this procurement should be only submitted in writing to the Designated City Contacts provided herein. Attempts by any prospective bidder to initiate contact with anyone other than the Designated City Contacts provided herein that the bidder believes can influence the procurement decision, e.g., Elected Officials, City Administrator, Selection Committee Members, Appointed Committee Members, etc., may lead to immediate elimination from further consideration.

Cost Liability

The City of Ann Arbor assumes no responsibility or liability for costs incurred by the Bidder prior to the execution of a contract with the City. By submitting a bid, a bidder agrees to bear all costs incurred or related to the preparation, submission and selection process for the bid.

Reservation of Rights

The City of Ann Arbor reserves the right to accept any bid or alternative bid proposed in whole or in part, to reject any or all bids or alternatives bids in whole or in part and to waive irregularity and/or informalities in any bid and to make the award in any manner deemed in the best interest of the City.

Idlefree Ordinance

The City of Ann Arbor adopted an idling reduction Ordinance that went into effect July 1, 2017. The full text of the ordinance (including exemptions) can be found at: www.a2gov.org/idlefree.

Under the ordinance, No Operator of a Commercial Vehicle shall cause or permit the Commercial Vehicle to Idle:

- (a) For any period of time while the Commercial Vehicle is unoccupied; or
- (b) For more than 5 minutes in any 60-minute period while the Commercial Vehicle is occupied.

In addition, generators and other internal combustion engines are covered

- (1) Excluding Motor Vehicle engines, no internal combustion engine shall be operated except

when it is providing power or electrical energy to equipment or a tool that is actively in use.

Environmental Commitment

The City of Ann Arbor recognizes its responsibility to minimize negative impacts on human health and the environment while supporting a vibrant community and economy. The City further recognizes that the products and services the City buys have inherent environmental and economic impacts and that the City should make procurement decisions that embody, promote, and encourage the City's commitment to the environment.

The City encourages potential vendors to bring forward emerging and progressive products and services that are best suited to the City's environmental principles.

INVITATION TO BID

City of Ann Arbor
Guy C. Larcom Municipal Building
Ann Arbor, Michigan 48107

Ladies and Gentlemen:

The undersigned, as Bidder, declares that this Bid is made in good faith, without fraud or collusion with any person or persons bidding on the same Contract; that this Bidder has carefully read and examined the bid documents, including City Nondiscrimination requirements and Declaration of Compliance Form, Living Wage requirements and Declaration of Compliance Form, Prevailing Wage requirements and Declaration of Compliance Form, Vendor Conflict of Interest Form, Notice of Pre-Bid Conference, Instructions to Bidders, Bid, Bid Forms, Contract, Bond Forms, General Conditions, Standard Specifications, Detailed Specifications, all Addenda, and the Plans (if applicable) and understands them. The Bidder declares that it conducted a full investigation at the site and of the work proposed and is fully informed as to the nature of the work and the conditions relating to the work's performance. The Bidder also declares that it and the major subcontractors have extensive experience in successfully completing projects similar to this one.

The Bidder acknowledges that it has not received or relied upon any representations or warrants of any nature whatsoever from the City of Ann Arbor, its agents or employees, and that this Bid is based solely upon the Bidder's own independent business judgment.

The undersigned proposes to perform all work shown on the plans or described in the bid documents, including any addenda issued, and to furnish all necessary machinery, tools, apparatus, and other means of construction to do all the work, furnish all the materials, and complete the work in strict accordance with all terms of the Contract of which this Bid is one part.

In accordance with these bid documents, and Addenda numbered _____, the undersigned, as Bidder, proposes to perform at the sites in and/or around Ann Arbor, Michigan, all the work included herein for the amounts set forth in the Bid Forms.

The Bidder declares that it has become fully familiar with the liquidated damage clauses for completion times and for compliance with City Code Chapter 112, understands and agrees that the liquidated damages are for the non-quantifiable aspects of non-compliance and do not cover actual damages that may be shown and agrees that if awarded the Contract, all liquidated damage clauses form part of the Contract.

The Bidder declares that it has become fully familiar with the provisions of Chapter 14, Section 1:320 (Prevailing wages) and Chapter 23 (Living Wage) of the Code of the City of Ann Arbor and that it understands and agrees to comply, to the extent applicable to employees providing services to the City under this Contract, with the wage and reporting requirements stated in the City Code provisions cited. Bidder certifies that the statements contained in the City Prevailing Wage and Living Wage Declaration of Compliance Forms are true and correct. Bidder further agrees that the cited provisions of Chapter 14 and Chapter 23 form a part of this Contract.

The Bidder declares that it has become familiar with the City Conflict of Interest Disclosure Form and certifies that the statement contained therein is true and correct.

The Bidder encloses a certified check or Bid Bond in the amount of 5% of the total of the Bid Price. The Bidder agrees both to contract for the work and to furnish the necessary Bonds and insurance documentation within 10 days after being notified of the acceptance of the Bid.

If this Bid is accepted by the City and the Bidder fails to contract and furnish the required Bonds and insurance documentation within 10 days after being notified of the acceptance of this Bid, then the Bidder shall be considered to have abandoned the Contract and the certified check or Bid Bond accompanying this Bid shall become due and payable to the City.

If the Bidder enters into the Contract in accordance with this Bid, or if this Bid is rejected, then the accompanying check or Bid Bond shall be returned to the Bidder.

In submitting this Bid, it is understood that the right is reserved by the City to accept any Bid, to reject any or all Bids, to waive irregularities and/or informalities in any Bid, and to make the award in any manner the City believes to be in its best interest.

SIGNED THIS _____ DAY OF _____, 202_.

Bidder's Name

Authorized Signature of Bidder

Official Address

(Print Name of Signer Above)

Telephone Number

Email Address for Award Notice

LEGAL STATUS OF BIDDER

(The Bidder shall fill out the appropriate form and strike out the other three.)

Bidder declares that it is:

* A corporation organized and doing business under the laws of the State of _____, for whom _____, bearing the office title of _____, whose signature is affixed to this Bid, is authorized to execute contracts.

NOTE: If not incorporated in Michigan, please attach the corporation's Certificate of Authority

• A limited liability company doing business under the laws of the State of _____, whom _____ bearing the title of _____ whose signature is affixed to this proposal, is authorized to execute contract on behalf of the LLC.

* A partnership, organized under the laws of the state of _____ and filed in the county of _____, whose members are (list all members and the street and mailing address of each) (attach separate sheet if necessary):

* An individual, whose signature with address, is affixed to this Bid: _____ (initial here)

Authorized Official

_____ **Date** _____, 202_

(Print) Name _____ Title _____

Company: _____

Address: _____

Contact Phone () _____ Fax () _____

Email _____

BID FORM

Section 1 – Schedule of Prices

Company: _____

Project: **WWTP Headworks Improvements Project**

Unit Price Bid –

<u>Item Description</u>	<u>Estimated Quantity</u>	<u>Unit Price</u>	<u>Total Price</u>
00 Division 00	1	LS	_____
01 Division 01	1	LS	_____
D-1 Demolition	1	LS	_____
C-1 Civil	1	LS	_____
Structural			
S-1 Pressure Injection of Non-weeping Cracks Repair Type 2A (1)	300	LF	_____
S-2 Pressure Injection of Weeping Cracks Repair Type 2B (2)	500	LF	_____
S-3 Concrete Surface Repair Type 3A (3)	600	SF	_____
S-4 Concrete Surface Repair Type 3B (4)	250	SF	_____
S-5 Concrete Surface Repair Type 3C (5)	1	SF	_____
S-6 Removal of Embedment's Repair Type 4 (6)	1	LS	_____
S-7 Aluminum Panel Replacement Type 5 (7)	1,200	SF	_____
S-8 All Remaining Structural Work (8)	1	LS	_____
Architectural			
A-1 Recaulk exterior joints and openings at repaired areas	1	LS	_____

A-2	Brick Repointing	150	LF	_____	_____
A-3	Paint lintels at repaired openings	4	EA	_____	_____
A-4	Brick replacement	6	EA	_____	_____
A-5	New doors	1	LS		_____
A-6	New duct openings	1	LS		_____
A-7	Electrical Room work	1	LS		_____

Process

P-1	Grit Removal & Washer Equipment (9)	1	LS		<u>\$710,000</u>
P-2	All Remaining Process Work (10)	1	LS		_____
P-3	Grit Removal Performance Testing	1	LS		<u>\$25,000</u>
Mechanical		1	LS		_____
Electrical		1	LS		_____
I&C / SCADA		1	LS		_____

Project Subtotal \$ _____

Duperon Screen System:

Duperon Fine Screen System (11)	\$ _____
Adjustments to above pricing to accommodate the Duperon Screen System (12)	\$ _____

Total Project Cost with Duperon Fine Screen System \$ _____

Hydro-Dyne Screen System:

Hydro-Dyne Screen System (13)	\$ _____
Adjustments to above pricing to accommodate the Hydro-Dyne Screen System (12)	\$ _____

Total Project Cost with Hydro-Dyne Fine Screen System \$ _____

The Owner will select the screen system and the Total Project Cost following the bid opening.

Notes:

1. S-1 Includes the work shown on Pressure Injection of Non-weeping Cracks Repair Type 2A Detail, Sheet S-2.
2. S-2 Includes the work shown on Pressure Injection of Weeping Cracks Repair Type 2B Detail, Sheet S-2.

3. S-3 Includes the work shown on Concrete Surface Repair Type 3A Detail, Sheet S-2.
4. S-4 Includes the work shown on Concrete Surface Repair Type 3B Detail, Sheet S-2.
5. S-5 Includes the work shown on Concrete Surface Repair Type 3C Detail, Sheet S-2.
6. S-6 Includes the work shown on Removal of Embedment's Repair Type 4 Detail, Sheet S-2.
7. S-7 Includes the work shown on Aluminum Panel Replacement Type 5 Detail, Sheet S-2.
8. S-8 Includes all structural work not included in any of the above structural items
9. The grit removal and washer equipment is sole-sourced, and a pre-negotiated price is included in this line item. Price includes shop drawing preparation, equipment supply, start-up services, warranty spare parts, etc. It does not include installation. It is incumbent upon each Bidder to fully understand the scope of the work provided by Huber prior to the Bid. Contractor shall include all other costs for the grit removal and washer equipment in line item P-2.
10. Line item cost does not include any costs associated with the fine screens itemize below the Project Subtotal line item.
11. Costs include all costs associated with the Duperon Screen System, including shop drawings, screen, washer, sluice equipment, instruments and controls, shipping, installation, start-up, spare parts, warranty and any other associated costs.
12. Cost adjustments (negative or positive) to demolition, concrete, can be identified on these line items to accommodate cost specific each screen system installation.
13. Costs include all costs associated with the HydroDyne Screen System, including shop drawings, screen, washer, sluice equipment, instruments and controls, shipping, installation, start-up, spare parts, warranty, and any other associated costs.

BID FORM

Section 2 – Material, Products, Equipment and Environmental Alternates

The Base Bid proposal price shall include materials, products and equipment selected from the designated items and manufacturers listed in the bidding documents. This is done to establish uniformity in bidding and to establish standards of quality for the items named.

If the Contractor wishes to quote alternate items for consideration by the City, it may do so under this Section. A complete description of the item and the proposed price differential must be provided. Unless approved at the time of award, substitutions where items are specifically named will be considered only as a negotiated change in Contract Sum.

If an environmental alternative is bid the City strongly encourages bidders to provide recent examples of product testing and previous successful use for the City to properly evaluate the environmental alternative. Testing data from independent accredited organizations are strongly preferred.

<u>Item Number</u>	<u>Description</u>	<u>Add/Deduct Amount</u>
--------------------	--------------------	--------------------------

If the Bidder does not suggest any material or equipment alternate, the Bidder **MUST** complete the following statement:

For the work outlined in this request for bid, the bidder does NOT propose any material, products or equipment alternate under the Contract.

Signature of Authorized Representative of Bidder _____ Date _____

BID FORM

Section 3 - Time Alternate

If the Bidder takes exception to the time stipulated in Article III of the Contract, Time of Completion, page C-2, it is requested to stipulate below its proposed time for performance of the work. Consideration will be given to time in evaluating bids.

If the Bidder does not suggest any time alternate, the Bidder **MUST** complete the following statement:

For the work outlined in this request for bid, the bidder does NOT propose any time alternate under the Contract.

Signature of Authorized Representative of Bidder _____ Date _____

BID FORM

Section 4 - Major Subcontractors

For purposes of this Contract, a Subcontractor is anyone (other than the Contractor) who performs work (other than or in addition to the furnishing of materials, plans or equipment) at or about the construction site, directly or indirectly for or on behalf of the Contractor (and whether or not in privity of Contract with the Contractor), but shall not include any individual who furnishes merely the individual's own personal labor or services. A Major Subcontractor is a Subcontractor who's total contracted price exceeds 10% of the Total Project Cost

Contractor agrees that all subcontracts entered into by the Contractor shall contain similar wage provision to Section 4 of the General Conditions covering subcontractor's employees who perform work on this contract.

For the work outlined in these documents the Bidder expects to engage the following major subcontractors to perform the work identified:

<u>Major Subcontractor (Name and Address)</u>	<u>Work</u>	<u>Amount</u>
---	-------------	---------------

If the Bidder does not expect to engage any major subcontractor, the Bidder **MUST** complete the following statement:

For the work outlined in this request for bid, the bidder does NOT expect to engage any major subcontractor to perform work under the Contract.

Signature of Authorized Representative of Bidder _____ Date _____

BID FORM

Section 5 – References

5A Contractor References:

Include a minimum of 5__ references from water or wastewater projects of similar scale or complexity completed within the past _10_ years.

[Refer also to Instructions to Bidders for additional requirements, if any]

1) _____
Project Name Cost Date Constructed

Contact Name Phone Number

2) _____
Project Name Cost Date Constructed

Contact Name Phone Number

3) _____
Project Name Cost Date Constructed

Contact Name Phone Number

4) _____
Project Name Cost Date Constructed

Contact Name Phone Number

5) _____
Project Name Cost Date Constructed

Contact Name Phone Number

5B Major Subcontractor References:

Include a minimum of 3 references from water or wastewater projects of similar scale or complexity completed within the past 10 years for each Major Subcontractor.

[Refer also to Instructions to Bidders for additional requirements, if any]

Major Subcontractor:.....

1) _____
Project Name Cost Date Constructed

Contact Name Phone Number

2) _____
Project Name Cost Date Constructed

Contact Name Phone Number

3) _____
Project Name Cost Date Constructed

Contact Name Phone Number

Major Subcontractor:.....

1) _____
Project Name Cost Date Constructed

Contact Name Phone Number

2) _____
Project Name Cost Date Constructed

Contact Name Phone Number

3) _____
Project Name Cost Date Constructed

Contact Name Phone Number

(Use additional sheets if needed)

BID FORM

Section 6 – Contractor Information and Responsible Contractor Criteria

Backup documentation may be requested at the sole discretion of the City to validate all of the responses provided herein by bidders. False statements by bidders to any of the criteria provided herein will result in the bid being considered non-responsive and will not be considered for award.

Failure to provide responses to all questions may result in being deemed non-responsive.

Attach additional pages as needed if space below is insufficient.

Pursuant to Sec 1:312(20) of the City Code which sets forth requirements of a responsible bidder, Bidder is required to submit the following:

1. Organization Name: _____

Social Security or Federal Employer I.D. #: _____

Address: _____

City: _____ State: _____ Zip: _____

Type of Organization (circle one below):

Individual Partnership Corporation Joint Venture Other

If "Other" please provide details on the organization:

Year organization established: _____

2. Current owners/principals/members/managing members/partners of the organization:

3. Assumed Names, "doing business as" d/b/a, and/or former organization names(s), if applicable: _____

Explanation of any business name changes:

4. If applicable, please provide a list of all bidder's litigation and arbitrations currently pending and within the past five years, including an explanation of each (parties, court/forum, legal claims, damages sought, and resolution).

5. Qualifications of management and supervisory personnel to be assigned by the bidder:

6. List the state and local licenses and license numbers held by the bidder:

7. Will all subcontractors, employees and other individuals working on the construction project maintain current applicable licenses required by law for all licensed occupations and professions?

Yes

No

8. Will contractors, subcontractors, employees, and other individuals working on the construction project be misclassified by bidder as independent contractors in violation of state or federal law?

Yes

No

9. Submit a statement as to what percentage of your work force resides within the City of Ann Arbor, and what percentage resides in Washtenaw County, Michigan, and the same information for any major subcontractors.

10. Submit documentation as to bidder's employee pay rates (e.g., certified payroll without SSN or personal identifying information, or chart of job titles and pay rates, or other evidence).

11. State whether bidder provides health insurance, pension or other retirement benefits, paid leave (vacation, personal time, sick leave, etc.), or other benefits to its employees, and if so, state whether each benefit is provided directly to employees, by payments or contributions to a third-party administered plan, in cash (e.g., fringe benefit portion of prevailing wages), or other manner.

12. State whether bidder is an equal opportunity employer and does not discriminate in its hiring on the basis of race, sex, pregnancy, age, religion, national origin, marital status, sexual orientation or gender identity, height, weight, or disability.

Yes

No

13. State whether bidder has Equal Employment Opportunity Programs for minorities, women, veterans, returning citizens, and small businesses, and if so, submit supporting documentation or other evidence of such program(s).

14. Has bidder had any violations of state, federal, or local laws or regulations, including OSHA or MIOSHA violations, state or federal prevailing wage laws, wage and hour laws, worker's compensation or unemployment compensation laws, rules or regulations, issued to or against the bidder within the past five years?

Yes

No

If you answered "yes" to the question above, for each violation provide an explanation of the nature of the violation, the agency involved, a violation or reference number, any other individual(s) or party(ies) involved, and the status or outcome and resolution.

15. Does bidder have an existing Fitness for Duty Program (drugs and alcohol testing) of each employee working on the proposed jobsite?

Yes

No

If you answered "Yes", please submit documentation of the Fitness for Duty Program and what it entails.

16. Submit documents or evidence of any debarment by any federal, state or local governmental unit and/or findings of non-responsibility or non-compliance with respect to any public or private construction project performed by the bidder.

17. Proof of insurance, including certificates of insurance, confirming existence and amount of coverage for liability, property damage, workers compensation, and any other insurances required by the proposed contract documents.

18. Does bidder have an on-going MIOSHA-approved safety-training program for employees to be used on the proposed job site?

Yes

No

If bidder answered "yes" to the question above, submit documentation of your safety-training program.

19. Does bidder have evidence of worker's compensation Experience Modification Rating ("EMR")?

Yes

No

EMR = _____

20. Will bidder use masters, journeypersons and apprentices on the project?

Yes

No

If bidder answered "yes" to the question above, provide the ratio of masters and journeypersons to apprentices for this project.

Ratio:_____

If bidder answered "no" to the question above, submit documentation regarding the qualifications of each worker who may or will be assigned on the project.

If, yes, Ratio = _____

21. Can bidder provide documentation that it participates in a Registered Apprenticeship Program (RAP) that is registered with the United States Department of Labor Office of Apprenticeship or by a State Apprenticeship Agency recognized by the Office of Apprenticeship?

Yes

No

If bidder answered "yes" to the question above, please submit a copy of the program document(s) and evidence of its registration.

If bidder answered "no" to the question above, please provide details on how you assess the skills and qualifications of any employees who do not have master or journeyperson certification or status, or are not participants in a Registered Apprenticeship Program.

22. Will bidder comply with all applicable state and federal laws and visa requirements regarding the hiring of non-US citizens, and disclosure of any work visas sought or obtained by the bidder, any of the bidder's subcontractors, or any of the bidder's employees or independent contractors, in order to perform any portion of the project?

Yes

No

23. Submit evidence that bidder has financial resources to start up and follow through on the project and to respond to damages in case of default as shown by written verification of bonding capacity equal to or exceeding the amount of the bidders scope of work on the project. The written verification must be submitted by a licensed surety company rated B+ or better in the current A.M. Best Guide and qualified to do business within the State of Michigan, and the same audited financial information for any subcontractor estimated to be paid more than \$100,000 related to any portion of the project.

24. Submit evidence of a quality assurance program used by the bidder and the results of same on the bidder's previous projects.

SAMPLE STANDARD CONTRACT

If a contract is awarded, the selected contractor will be required to adhere to a set of general contract provisions which will become a part of any formal agreement. These provisions are general principles which apply to all contractors of service to the City of Ann Arbor such as the following:

Administrative Use Only
Contract Date: _____

CONTRACT

THIS CONTRACT is between the CITY OF ANN ARBOR, a Michigan Municipal Corporation, 301 East Huron Street, Ann Arbor, Michigan 48104 ("City") and _____ ("Contractor")

(An individual/partnership/corporation, include state of incorporation) (Address)

Based upon the mutual promises below, the Contractor and the City agree as follows:

ARTICLE I - Scope of Work

The Contractor agrees to furnish all of the materials, equipment and labor necessary; and to abide by all the duties and responsibilities applicable to it for the project titled **Headworks Improvements Project, ITB NO 4706**. in accordance with the requirements and provisions of the following documents, including all written modifications incorporated into any of the documents, all of which are incorporated as part of this Contract:

Non-discrimination and Living Wage Declaration of Compliance Forms (if applicable)	General Conditions
Vendor Conflict of Interest Form	Standard Specifications
Prevailing Wage Declaration of Compliance Form (if applicable)	Detailed Specifications
Bid Forms	Plans
Contract and Exhibits	Addenda
Bonds	

ARTICLE II - Definitions

Administering Service Area/Unit means **Wastewater Treatment Services**

Project means **WWTP Headworks Improvements Project and Bid Number**

Supervising Professional means the person acting under the authorization of the manager of the Administering Service Area/Unit. At the time this Contract is executed, the Supervising Professional is: Chris Englert whose job title is WTS Engineer. If there is any question concerning who the Supervising Professional is, Contractor shall confirm with the manager of the Administering Service Area/Unit.

Contractor's Representative means _____ [Insert name] whose job title is _____ [Insert job title].

ARTICLE III - Time of Completion

- (A) The work to be completed under this Contract shall begin immediately on the date specified in the Notice to Proceed (NTP) issued by the City.
- (B) The work shall be Substantially Complete within 600 consecutive calendar days from the NTP. The entire work for this Contract – Final Completion – shall be completed within 60 consecutive calendar days of Substantial Completion
- © Failure to complete all the work within the time specified above, including any extension granted in writing by the Supervising Professional, shall obligate the Contractor to pay the City, as liquidated damages and not as a penalty, an amount equal to \$1,500 for each calendar day of delay in Substantial Completion, and \$1,000 for each calendar day of delay in Final Completion.. If any liquidated damages are unpaid by the Contractor, the City shall be entitled to deduct these unpaid liquidated damages from the monies due the Contractor.

The liquidated damages are for the non-quantifiable aspects of any of the previously identified events and do not cover actual damages that can be shown or quantified nor are they intended to preclude recovery of actual damages in addition to the recovery of liquidated damages.

ARTICLE IV - The Contract Sum

- (A) The City shall pay to the Contractor for the performance of the Contract, the unit prices as given in the Bid Form for the estimated bid total of:

_____ Dollars (\$_____)

ARTICLE V - Assignment

This Contract may not be assigned or subcontracted any portion of any right or obligation under this contract without the written consent of the City. Notwithstanding any consent by the City to any assignment, Contractor shall at all times remain bound to all warranties, certifications, indemnifications, promises and performances, however described, as are required of it under this contract unless specifically released from the requirement, in writing, by the City.

ARTICLE VI - Choice of Law

This Contract shall be construed, governed, and enforced in accordance with the laws of the State of Michigan. By executing this Contract, the Contractor and the City agree to venue in a court of appropriate jurisdiction sitting within Washtenaw County for purposes of any action arising under this Contract. The parties stipulate that the venue referenced in this Contract is for convenience

and waive any claim of non-convenience.

Whenever possible, each provision of the Contract will be interpreted in a manner as to be effective and valid under applicable law. The prohibition or invalidity, under applicable law, of any provision will not invalidate the remainder of the Contract.

ARTICLE VII - Relationship of the Parties

The parties of the Contract agree that it is not a Contract of employment but is a Contract to accomplish a specific result. Contractor is an independent Contractor performing services for the City. Nothing contained in this Contract shall be deemed to constitute any other relationship between the City and the Contractor.

Contractor certifies that it has no personal or financial interest in the project other than the compensation it is to receive under the Contract. Contractor certifies that it is not, and shall not become, overdue or in default to the City for any Contract, debt, or any other obligation to the City including real or personal property taxes. City shall have the right to set off any such debt against compensation awarded for services under this Contract.

ARTICLE VIII - Notice

All notices given under this Contract shall be in writing, and shall be by personal delivery or by certified mail with return receipt requested to the parties at their respective addresses as specified in the Contract Documents or other address the Contractor may specify in writing. Notice will be deemed given on the date when one of the following first occur: (1) the date of actual receipt; or (2) three days after mailing certified U.S. mail.

ARTICLE IX - Indemnification

To the fullest extent permitted by law, Contractor shall indemnify, defend and hold the City, its officers, employees and agents harmless from all suits, claims, judgments and expenses including attorney's fees resulting or alleged to result, in whole or in part, from any act or omission, which is in any way connected or associated with this Contract, by the Contractor or anyone acting on the Contractor's behalf under this Contract. Contractor shall not be responsible to indemnify the City for losses or damages caused by or resulting from the City's sole negligence. The provisions of this Article shall survive the expiration or earlier termination of this contract for any reason.

ARTICLE X - Entire Agreement

This Contract represents the entire understanding between the City and the Contractor and it supersedes all prior representations, negotiations, agreements, or understandings whether written or oral. Neither party has relied on any prior representations in entering into this Contract. No terms or conditions of either party's invoice, purchase order or other administrative document shall modify the terms and conditions of this Contract, regardless of the other party's failure to object to such form. This Contract shall be binding on and shall inure to the benefit of the parties to this Contract and their permitted successors and permitted assigns and nothing in this Contract, express or implied, is intended to or shall confer on any other person or entity any legal or equitable right, benefit, or remedy of any nature whatsoever under or by reason of this Contract. This Contract may be altered, amended or modified only by written amendment signed by the City and the Contractor.

ARTICLE XI – Electronic Transactions

The City and Contractor agree that signatures on this Contract may be delivered electronically in lieu of an original signature and agree to treat electronic signatures as original signatures that bind them to this Contract. This Contract may be executed and delivered by facsimile and upon such delivery, the facsimile signature will be deemed to have the same effect as if the original signature had been delivered to the other party.

FOR CONTRACTOR

By _____

Its: _____

FOR THE CITY OF ANN ARBOR

By _____
Christopher Taylor, Mayor

By _____
Jacqueline Beaudry, City Clerk

Approved as to substance

By _____
Milton Dohoney Jr., Interim City
Administrator

By _____
Craig Hupy, Public Services Area
Administrator

Approved as to form and content

Stephen K. Postema, City Attorney

PERFORMANCE BOND

- (1) _____ (referred to as "Principal"),
and _____, a corporation duly authorized
to do business in the State of Michigan (referred to as "Surety"), are bound to the City of Ann Arbor,
Michigan (referred to as "City"), for \$ _____, the payment of which Principal and Surety bind
themselves, their heirs, executors, administrators, successors and assigns, jointly and severally,
by this bond.
- (2) The Principal has entered a written Contract with the City entitled WWTP Headworks Improvement
Project, for ITB No. 4706 and this bond is given for that Contract in compliance with Act No. 213
of the Michigan Public Acts of 1963, as amended, being MCL 129.201 *et seq.*
- (3) Whenever the Principal is declared by the City to be in default under the Contract, the Surety may
promptly remedy the default or shall promptly:
- (a) complete the Contract in accordance with its terms and conditions; or
- (b) obtain a bid or bids for submission to the City for completing the Contract in accordance with
its terms and conditions, and upon determination by Surety of the lowest responsible bidder,
arrange for a Contract between such bidder and the City, and make available, as work progresses,
sufficient funds to pay the cost of completion less the balance of the Contract price; but not
exceeding, including other costs and damages for which Surety may be liable hereunder, the
amount set forth in paragraph 1.
- (4) Surety shall have no obligation to the City if the Principal fully and promptly performs under the
Contract.
- (5) Surety agrees that no change, extension of time, alteration or addition to the terms of the Contract
or to the work to be performed thereunder, or the specifications accompanying it shall in any way
affect its obligations on this bond, and waives notice of any such change, extension of time,
alteration or addition to the terms of the Contract or to the work, or to the specifications.
- (6) Principal, Surety, and the City agree that signatures on this bond may be delivered electronically
in lieu of an original signature and agree to treat electronic signatures as original signatures that
bind them to this bond. This bond may be executed and delivered by facsimile and upon such
delivery, the facsimile signature will be deemed to have the same effect as if the original signature
had been delivered to the other party.

SIGNED AND SEALED this _____ day of _____, 202_.

(Name of Surety Company)

By _____
(Signature)

Its _____
(Title of Office)

Approved as to form:

Stephen K. Postema, City Attorney

(Name of Principal)

By _____
(Signature)

Its _____
(Title of Office)

Name and address of agent:

LABOR AND MATERIAL BOND

- (1) _____
of _____ (referred to as "Principal"), and _____, a corporation duly authorized to do business in the State of Michigan, (referred to as "Surety"), are bound to the City of Ann Arbor, Michigan (referred to as "City"), for the use and benefit of claimants as defined in Act 213 of Michigan Public Acts of 1963, as amended, being MCL 129.201 et seq., in the amount of \$ _____, for the payment of which Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, by this bond.
- (2) The Principal has entered a written Contract with the City entitled WWTP Headworks Improvements Project, for ITB No. 4706; and this bond is given for that Contract in compliance with Act No. 213 of the Michigan Public Acts of 1963 as amended;
- (3) If the Principal fails to promptly and fully repay claimants for labor and material reasonably required under the Contract, the Surety shall pay those claimants.
- (4) Surety's obligations shall not exceed the amount stated in paragraph 1, and Surety shall have no obligation if the Principal promptly and fully pays the claimants.
- (5) Principal, Surety, and the City agree that signatures on this bond may be delivered electronically in lieu of an original signature and agree to treat electronic signatures as original signatures that bind them to this bond. This bond may be executed and delivered by facsimile and upon such delivery, the facsimile signature will be deemed to have the same effect as if the original signature had been delivered to the other party.

SIGNED AND SEALED this _____ day of _____, 202_

(Name of Surety Company)

By _____
(Signature)

Its _____
(Title of Office)

Approved as to form:

Stephen K. Postema, City Attorney

(Name of Principal)

By _____
(Signature)

Its _____
(Title of Office)

Name and address of agent:

GENERAL CONDITIONS

Section 1 - Execution, Correlation and Intent of Documents

The contract documents shall be signed in 2 copies by the City and the Contractor.

The contract documents are complementary and what is called for by any one shall be binding. The intention of the documents is to include all labor and materials, equipment and transportation necessary for the proper execution of the work. Materials or work described in words which so applied have a well-known technical or trade meaning have the meaning of those recognized standards.

In case of a conflict among the contract documents listed below in any requirement(s), the requirement(s) of the document listed first shall prevail over any conflicting requirement(s) of a document listed later.

(1) Addenda in reverse chronological order; (2) Detailed Specifications; (3) Standard Specifications; (4) Plans; (5) General Conditions; (6) Contract; (7) Bid Forms; (8) Bond Forms; (9) Bid.

Section 2 - Order of Completion

The Contractor shall submit with each invoice, and at other times reasonably requested by the Supervising Professional, schedules showing the order in which the Contractor proposes to carry on the work. They shall include the dates at which the Contractor will start the several parts of the work, the estimated dates of completion of the several parts, and important milestones within the several parts.

Section 3 - Familiarity with Work

The Bidder or its representative shall make personal investigations of the site of the work and of existing structures and shall determine to its own satisfaction the conditions to be encountered, the nature of the ground, the difficulties involved, and all other factors affecting the work proposed under this Contract. The Bidder to whom this Contract is awarded will not be entitled to any additional compensation unless conditions are clearly different from those which could reasonably have been anticipated by a person making diligent and thorough investigation of the site.

The Bidder shall immediately notify the City upon discovery, and in every case prior to submitting its Bid, of every error or omission in the bidding documents that would be identified by a reasonably competent, diligent Bidder. In no case will a Bidder be allowed the benefit of extra compensation or time to complete the work under this Contract for extra expenses or time spent as a result of the error or omission.

Section 4 - Wage Requirements

Under this Contract, the Contractor shall conform to Chapter 14 of Title I of the Code of the City of Ann Arbor as amended; which in part states "...that all craftsmen, mechanics and laborers employed directly on the site in connection with said improvements, including said employees of

subcontractors, shall receive the prevailing wage for the corresponding classes of craftsmen, mechanics and laborers, as determined by statistics for the Ann Arbor area compiled by the United States Department of Labor. At the request of the City, any contractor or subcontractor shall provide satisfactory proof of compliance with the contract provisions required by the Section.

Pursuant to Resolution R-16-469 all public improvement contractors are subject to prevailing wage and will be required to provide to the City payroll records sufficient to demonstrate compliance with the prevailing wage requirements. A sample Prevailing Wage Form is provided in the Appendix herein for reference as to what will be expected from contractors. Use of the Prevailing Wage Form provided in the Appendix section or a City-approved equivalent will be required along with wage rate interviews.

Where the Contract and the Ann Arbor City Ordinance are silent as to definitions of terms required in determining contract compliance with regard to prevailing wages, the definitions provided in the Davis-Bacon Act as amended (40 U.S.C. 278-a to 276-a-7) for the terms shall be used.

If the Contractor is a "covered employer" as defined in Chapter 23 of the Ann Arbor City Code, the Contractor agrees to comply with the living wage provisions of Chapter 23 of the Ann Arbor City Code. The Contractor agrees to pay those employees providing Services to the City under this Contract a "living wage," as defined in Section 1:815 of the Ann Arbor City Code, as adjusted in accordance with Section 1:815(3); to post a notice approved by the City of the applicability of Chapter 23 in every location in which regular or contract employees providing services under this Contract are working; to maintain records of compliance; if requested by the City, to provide documentation to verify compliance; to take no action that would reduce the compensation, wages, fringe benefits, or leave available to any employee or person contracted for employment in order to pay the living wage required by Section 1:815; and otherwise to comply with the requirements of Chapter 23.

Contractor agrees that all subcontracts entered into by the Contractor shall contain similar wage provision covering subcontractor's employees who perform work on this contract.

Section 5 - Non-Discrimination

The Contractor agrees to comply, and to require its subcontractor(s) to comply, with the nondiscrimination provisions of MCL 37.2209. The Contractor further agrees to comply with the provisions of Section 9:158 of Chapter 112 of Title IX of the Ann Arbor City Code, and to assure that applicants are employed and that employees are treated during employment in a manner which provides equal employment opportunity.

Section 6 - Materials, Appliances, Employees

Unless otherwise stipulated, the Contractor shall provide and pay for all materials, labor, water, tools, equipment, light, power, transportation, and other facilities necessary or used for the execution and completion of the work. Unless otherwise specified, all materials incorporated in the permanent work shall be new, and both workmanship and materials shall be of the highest quality. The Contractor shall furnish satisfactory evidence as to the kind and quality of materials.

The Contractor shall at all times enforce strict discipline and good order among its employees, and shall seek to avoid employing on the work any unfit person or anyone not skilled in the work assigned.

Adequate sanitary facilities shall be provided by the Contractor.

Section 7 - Qualifications for Employment

The Contractor shall employ competent laborers and mechanics for the work under this Contract. For work performed under this Contract, employment preference shall be given to qualified local residents.

Section 8 - Royalties and Patents

The Contractor shall pay all royalties and license fees. It shall defend all suits or claims for infringements of any patent rights and shall hold the City harmless from loss on account of infringement except that the City shall be responsible for all infringement loss when a particular process or the product of a particular manufacturer or manufacturers is specified, unless the City has notified the Contractor prior to the signing of the Contract that the particular process or product is patented or is believed to be patented.

Section 9 - Permits and Regulations

The Contractor must secure and pay for all permits, permit or plan review fees and licenses necessary for the prosecution of the work. These include but are not limited to City building permits, right-of-way permits, lane closure permits, right-of-way occupancy permits, and the like. The City shall secure and pay for easements shown on the plans unless otherwise specified.

The Contractor shall give all notices and comply with all laws, ordinances, rules and regulations bearing on the conduct of the work as drawn and specified. If the Contractor observes that the contract documents are at variance with those requirements, it shall promptly notify the Supervising Professional in writing, and any necessary changes shall be adjusted as provided in the Contract for changes in the work.

Section 10 - Protection of the Public and of Work and Property

The Contractor is responsible for the means, methods, sequences, techniques and procedures of construction and safety programs associated with the work contemplated by this contract. The Contractor, its agents or sub-contractors, shall comply with the "General Rules and Regulations for the Construction Industry" as published by the Construction Safety Commission of the State of Michigan and to all other local, State and National laws, ordinances, rules and regulations pertaining to safety of persons and property.

The Contractor shall take all necessary and reasonable precautions to protect the safety of the public. It shall continuously maintain adequate protection of all work from damage, and shall take all necessary and reasonable precautions to adequately protect all public and private property from injury or loss arising in connection with this Contract. It shall make good any damage, injury or loss to its work and to public and private property resulting from lack of reasonable protective precautions, except as may be due to errors in the contract documents, or caused by agents or employees of the City. The Contractor shall obtain and maintain sufficient insurance to cover damage to any City property at the site by any cause.

In an emergency affecting the safety of life, or the work, or of adjoining property, the Contractor

is, without special instructions or authorization from the Supervising Professional, permitted to act at its discretion to prevent the threatened loss or injury. It shall also so act, without appeal, if authorized or instructed by the Supervising Professional.

Any compensation claimed by the Contractor for emergency work shall be determined by agreement or in accordance with the terms of Claims for Extra Cost - Section 15.

Section 11 - Inspection of Work

The City shall provide sufficient competent personnel for the inspection of the work.

The Supervising Professional shall at all times have access to the work whenever it is in preparation or progress, and the Contractor shall provide proper facilities for access and for inspection.

If the specifications, the Supervising Professional's instructions, laws, ordinances, or any public authority require any work to be specially tested or approved, the Contractor shall give the Supervising Professional timely notice of its readiness for inspection, and if the inspection is by an authority other than the Supervising Professional, of the date fixed for the inspection. Inspections by the Supervising Professional shall be made promptly, and where practicable at the source of supply. If any work should be covered up without approval or consent of the Supervising Professional, it must, if required by the Supervising Professional, be uncovered for examination and properly restored at the Contractor's expense.

Re-examination of any work may be ordered by the Supervising Professional, and, if so ordered, the work must be uncovered by the Contractor. If the work is found to be in accordance with the contract documents, the City shall pay the cost of re-examination and replacement. If the work is not in accordance with the contract documents, the Contractor shall pay the cost.

Section 12 - Superintendence

The Contractor shall keep on the work site, during its progress, a competent superintendent and any necessary assistants, all satisfactory to the Supervising Professional. The superintendent will be responsible to perform all on-site project management for the Contractor. The superintendent shall be experienced in the work required for this Contract. The superintendent shall represent the Contractor and all direction given to the superintendent shall be binding as if given to the Contractor. Important directions shall immediately be confirmed in writing to the Contractor. Other directions will be confirmed on written request. The Contractor shall give efficient superintendence to the work, using its best skill and attention.

Section 13 - Changes in the Work

The City may make changes to the quantities of work within the general scope of the Contract at any time by a written order and without notice to the sureties. If the changes add to or deduct from the extent of the work, the Contract Sum shall be adjusted accordingly. All the changes shall be executed under the conditions of the original Contract except that any claim for extension of time caused by the change shall be adjusted at the time of ordering the change.

In giving instructions, the Supervising Professional shall have authority to make minor changes in the work not involving extra cost and not inconsistent with the purposes of the work, but otherwise,

except in an emergency endangering life or property, no extra work or change shall be made unless in pursuance of a written order by the Supervising Professional, and no claim for an addition to the Contract Sum shall be valid unless the additional work was ordered in writing.

The Contractor shall proceed with the work as changed and the value of the work shall be determined as provided in Claims for Extra Cost - Section 15.

Section 14 - Extension of Time

Extension of time stipulated in the Contract for completion of the work will be made if and as the Supervising Professional may deem proper under any of the following circumstances:

- (1) When work under an extra work order is added to the work under this Contract;
- (2) When the work is suspended as provided in Section 20;
- (3) When the work of the Contractor is delayed on account of conditions which could not have been foreseen, or which were beyond the control of the Contractor, and which were not the result of its fault or negligence;
- (4) Delays in the progress of the work caused by any act or neglect of the City or of its employees or by other Contractors employed by the City;
- (5) Delay due to an act of Government;
- (6) Delay by the Supervising Professional in the furnishing of plans and necessary information;
- (7) Other cause which in the opinion of the Supervising Professional entitles the Contractor to an extension of time.

The Contractor shall notify the Supervising Professional within 7 days of an occurrence or conditions which, in the Contractor's opinion, entitle it to an extension of time. The notice shall be in writing and submitted in ample time to permit full investigation and evaluation of the Contractor's claim. The Supervising Professional shall acknowledge receipt of the Contractor's notice within 7 days of its receipt. Failure to timely provide the written notice shall constitute a waiver by the Contractor of any claim.

In situations where an extension of time in contract completion is appropriate under this or any other section of the contract, the Contractor understands and agrees that the only available adjustment for events that cause any delays in contract completion shall be extension of the required time for contract completion and that there shall be no adjustments in the money due the Contractor on account of the delay.

Section 15 - Claims for Extra Cost

If the Contractor claims that any instructions by drawings or other media issued after the date of the Contract involved extra cost under this Contract, it shall give the Supervising Professional written notice within 7 days after the receipt of the instructions, and in any event before proceeding to execute the work, except in emergency endangering life or property. The procedure shall then be as provided for Changes in the Work-Section 13. No claim shall be valid unless so made.

If the Supervising Professional orders, in writing, the performance of any work not covered by the contract documents, and for which no item of work is provided in the Contract, and for which no unit price or lump sum basis can be agreed upon, then the extra work shall be done on a Cost-Plus-Percentage basis of payment as follows:

- (1) The Contractor shall be reimbursed for all reasonable costs incurred in doing the work, and shall receive an additional payment of 15% of all the reasonable costs to cover both its indirect overhead costs and profit;
- (2) The term "Cost" shall cover all payroll charges for employees and supervision required under the specific order, together with all worker's compensation, Social Security, pension and retirement allowances and social insurance, or other regular payroll charges on same; the cost of all material and supplies required of either temporary or permanent character; rental of all power-driven equipment at agreed upon rates, together with cost of fuel and supply charges for the equipment; and any costs incurred by the Contractor as a direct result of executing the order, if approved by the Supervising Professional;
- (3) If the extra is performed under subcontract, the subcontractor shall be allowed to compute its charges as described above. The Contractor shall be permitted to add an additional charge of 5% percent to that of the subcontractor for the Contractor's supervision and contractual responsibility, to which there is a maximum additional charge of 20%;
- (4) The quantities and items of work done each day shall be submitted to the Supervising Professional in a satisfactory form on the succeeding day, and shall be approved by the Supervising Professional and the Contractor or adjusted at once;
- (5) Payments of all charges for work under this Section in any one month shall be made along with normal progress payments. Retainage shall be in accordance with Progress Payments-Section 16.

No additional compensation will be provided for additional equipment, materials, personnel, overtime or special charges required to perform the work within the time requirements of the Contract.

When extra work is required and no suitable price for machinery and equipment can be determined in accordance with this Section, the hourly rate paid shall be 1/40 of the basic weekly rate listed in the Rental Rate Blue Book published by Dataquest Incorporated and applicable to the time period the equipment was first used for the extra work. The hourly rate will be deemed to include all costs of operation such as bucket or blade, fuel, maintenance, "regional factors", insurance, taxes, and the like, but not the costs of the operator.

Section 16 - Progress Payments

The Contractor shall submit each month, or at longer intervals, if it so desires, an invoice covering work performed for which it believes payment, under the Contract terms, is due. The submission shall be to the City's Finance Department - Accounting Division. The Supervising Professional will, within 10 days following submission of the invoice, prepare a certificate for payment for the work in an amount to be determined by the Supervising Professional as fairly representing the acceptable work performed during the period covered by the Contractor's invoice. To insure the proper performance of this Contract, the City will retain a percentage of the estimate in accordance with Act 524, Public Acts of 1980. The City will then, following the receipt of the Supervising Professional's Certificate, make payment to the Contractor as soon as feasible, which is anticipated will be within 15 days.

An allowance may be made in progress payments if substantial quantities of permanent material have been delivered to the site but not incorporated in the completed work if the Contractor, in the opinion of the Supervising Professional, is diligently pursuing the work under this Contract. Such materials shall be properly stored and adequately protected. Allowance in the estimate shall be at the invoice price value of the items. Notwithstanding any payment of any allowance, all risk of loss due to vandalism or any damages to the stored materials remains with the Contractor.

In the case of Contracts which include only the Furnishing and Delivering of Equipment, the payments shall be; 60% of the Contract Sum upon the delivery of all equipment to be furnished, or in the case of delivery of a usable portion of the equipment in advance of the total equipment delivery, 60% of the estimated value of the portion of the equipment may be paid upon its delivery in advance of the time of the remainder of the equipment to be furnished; 30% of the Contract Sum upon completion of erection of all equipment furnished, but not later than 60 days after the date of delivery of all of the equipment to be furnished; and payment of the final 10% on final completion of erection, testing and acceptance of all the equipment to be furnished; but not later than 180 days after the date of delivery of all of the equipment to be furnished, unless testing has been completed and shows the equipment to be unacceptable.

With each invoice for periodic payment, the Contractor shall enclose a Contractor's Declaration - Section 43, and an updated project schedule per Order of Completion - Section 2.

Section 17 - Deductions for Uncorrected Work

If the Supervising Professional decides it is inexpedient to correct work that has been damaged or that was not done in accordance with the Contract, an equitable deduction from the Contract price shall be made.

Section 18 - Correction of Work Before Final Payment

The Contractor shall promptly remove from the premises all materials condemned by the Supervising Professional as failing to meet Contract requirements, whether incorporated in the work or not, and the Contractor shall promptly replace and re-execute the work in accordance with the Contract and without expense to the City and shall bear the expense of making good all work of other contractors destroyed or damaged by the removal or replacement.

If the Contractor does not remove the condemned work and materials within 10 days after written notice, the City may remove them and, if the removed material has value, may store the material

at the expense of the Contractor. If the Contractor does not pay the expense of the removal within 10 days thereafter, the City may, upon 10 days written notice, sell the removed materials at auction or private sale and shall pay to the Contractor the net proceeds, after deducting all costs and expenses that should have been borne by the Contractor. If the removed material has no value, the Contractor must pay the City the expenses for disposal within 10 days of invoice for the disposal costs.

The inspection or lack of inspection of any material or work pertaining to this Contract shall not relieve the Contractor of its obligation to fulfill this Contract and defective work shall be made good. Unsuitable materials may be rejected by the Supervising Professional notwithstanding that the work and materials have been previously overlooked by the Supervising Professional and accepted or estimated for payment or paid for. If the work or any part shall be found defective at any time before the final acceptance of the whole work, the Contractor shall forthwith make good the defect in a manner satisfactory to the Supervising Professional. The judgment and the decision of the Supervising Professional as to whether the materials supplied and the work done under this Contract comply with the requirements of the Contract shall be conclusive and final.

Section 19 - Acceptance and Final Payment

Upon receipt of written notice that the work is ready for final inspection and acceptance, the Supervising Professional will promptly make the inspection. When the Supervising Professional finds the work acceptable under the Contract and the Contract fully performed, the Supervising Professional will promptly sign and issue a final certificate stating that the work required by this Contract has been completed and is accepted by the City under the terms and conditions of the Contract. The entire balance found to be due the Contractor, including the retained percentage, shall be paid to the Contractor by the City within 30 days after the date of the final certificate.

Before issuance of final certificates, the Contractor shall file with the City:

- (1) The consent of the surety to payment of the final estimate;
- (2) The Contractor's Affidavit in the form required by Section 44.

In case the Affidavit or consent is not furnished, the City may retain out of any amount due the Contractor, sums sufficient to cover all lienable claims.

The making and acceptance of the final payment shall constitute a waiver of all claims by the City except those arising from:

- (1) unsettled liens;
- (2) faulty work appearing within the warranty period;
- (3) hidden defects in meeting the requirements of the plans and specifications;
- (4) manufacturer's guarantees.

It shall also constitute a waiver of all claims by the Contractor, except those previously made and still unsettled.

Section 20 - Suspension of Work

The City may at any time suspend the work, or any part by giving 5 days notice to the Contractor in writing. The work shall be resumed by the Contractor within 10 days after the date fixed in the

written notice from the City to the Contractor to do so. The City shall reimburse the Contractor for expense incurred by the Contractor in connection with the work under this Contract as a result of the suspension.

If the work, or any part, shall be stopped by the notice in writing, and if the City does not give notice in writing to the Contractor to resume work at a date within 90 days of the date fixed in the written notice to suspend, then the Contractor may abandon that portion of the work suspended and will be entitled to the estimates and payments for all work done on the portions abandoned, if any, plus 10% of the value of the work abandoned, to compensate for loss of overhead, plant expense, and anticipated profit.

Section 21 - Delays and the City's Right to Terminate Contract

If the Contractor refuses or fails to prosecute the work, or any separate part of it, with the diligence required to insure completion, ready for operation, within the allowable number of consecutive calendar days specified plus extensions, or fails to complete the work within the required time, the City may, by written notice to the Contractor, terminate its right to proceed with the work or any part of the work as to which there has been delay. After providing the notice the City may take over the work and prosecute it to completion, by contract or otherwise, and the Contractor and its sureties shall be liable to the City for any excess cost to the City. If the Contractor's right to proceed is terminated, the City may take possession of and utilize in completing the work, any materials, appliances and plant as may be on the site of the work and useful for completing the work. The right of the Contractor to proceed shall not be terminated or the Contractor charged with liquidated damages where an extension of time is granted under Extension of Time - Section 14.

If the Contractor is adjudged a bankrupt, or if it makes a general assignment for the benefit of creditors, or if a receiver is appointed on account of its insolvency, or if it persistently or repeatedly refuses or fails except in cases for which extension of time is provided, to supply enough properly skilled workers or proper materials, or if it fails to make prompt payments to subcontractors or for material or labor, or persistently disregards laws, ordinances or the instructions of the Supervising Professional, or otherwise is guilty of a substantial violation of any provision of the Contract, then the City, upon the certificate of the Supervising Professional that sufficient cause exists to justify such action, may, without prejudice to any other right or remedy and after giving the Contractor 3 days written notice, terminate this Contract. The City may then take possession of the premises and of all materials, tools and appliances thereon and without prejudice to any other remedy it may have, make good the deficiencies or finish the work by whatever method it may deem expedient, and deduct the cost from the payment due the Contractor. The Contractor shall not be entitled to receive any further payment until the work is finished. If the expense of finishing the work, including compensation for additional managerial and administrative services exceeds the unpaid balance of the Contract Sum, the Contractor and its surety are liable to the City for any excess cost incurred. The expense incurred by the City, and the damage incurred through the Contractor's default, shall be certified by the Supervising Professional.

Section 22 - Contractor's Right to Terminate Contract

If the work should be stopped under an order of any court, or other public authority, for a period of 3 months, through no act or fault of the Contractor or of anyone employed by it, then the Contractor may, upon 7 days written notice to the City, terminate this Contract and recover from the City payment for all acceptable work executed plus reasonable profit.

Section 23 - City's Right To Do Work

If the Contractor should neglect to prosecute the work properly or fail to perform any provision of this Contract, the City, 3 days after giving written notice to the Contractor and its surety may, without prejudice to any other remedy the City may have, make good the deficiencies and may deduct the cost from the payment due to the Contractor.

Section 24 - Removal of Equipment and Supplies

In case of termination of this Contract before completion, from any or no cause, the Contractor, if notified to do so by the City, shall promptly remove any part or all of its equipment and supplies from the property of the City, failing which the City shall have the right to remove the equipment and supplies at the expense of the Contractor.

The removed equipment and supplies may be stored by the City and, if all costs of removal and storage are not paid by the Contractor within 10 days of invoicing, the City upon 10 days written notice may sell the equipment and supplies at auction or private sale, and shall pay the Contractor the net proceeds after deducting all costs and expenses that should have been borne by the Contractor and after deducting all amounts claimed due by any lien holder of the equipment or supplies.

Section 25 - Responsibility for Work and Warranties

The Contractor assumes full responsibility for any and all materials and equipment used in the construction of the work and may not make claims against the City for damages to materials and equipment from any cause except negligence or willful act of the City. Until its final acceptance, the Contractor shall be responsible for damage to or destruction of the project (except for any part covered by Partial Completion and Acceptance - Section 26). The Contractor shall make good all work damaged or destroyed before acceptance. All risk of loss remains with the Contractor until final acceptance of the work (Section 19) or partial acceptance (Section 26). The Contractor is advised to investigate obtaining its own builders risk insurance.

The Contractor shall guarantee the quality of the work for a period of two years from Substantial Completion. The Contractor shall also unconditionally guarantee the quality of all equipment and materials that are furnished and installed under the contract for a period of two years. At the end of two years after the Contractor's receipt of final payment, the complete work, including equipment and materials furnished and installed under the contract, shall be inspected by the Contractor and the Supervising Professional. Any defects shall be corrected by the Contractor at its expense as soon as practicable but in all cases within 60 days. Any defects that are identified prior to the end of one year shall also be inspected by the Contractor and the Supervising Professional and shall be corrected by the Contractor at its expense as soon as practicable but in all cases within 60 days.

The Contractor shall assign all manufacturer or material supplier extended warranties to the City prior to final payment. The assignment shall not relieve the Contractor of its obligations under this paragraph to correct defects.

Section 26 - Partial Completion and Acceptance

If at any time prior to the issuance of the final certificate referred to in Acceptance and Final Payment - Section 19, any portion of the permanent construction has been satisfactorily completed, and if the Supervising Professional determines that portion of the permanent construction is not required for the operations of the Contractor but is needed by the City, the Supervising Professional shall issue to the Contractor a certificate of partial completion, and immediately the City may take over and use the portion of the permanent construction described in the certificate, and exclude the Contractor from that portion.

The issuance of a certificate of partial completion shall not constitute an extension of the Contractor's time to complete the portion of the permanent construction to which it relates if the Contractor has failed to complete it in accordance with the terms of this Contract. The issuance of the certificate shall not release the Contractor or its sureties from any obligations under this Contract including bonds.

If prior use increases the cost of, or delays the work, the Contractor shall be entitled to extra compensation, or extension of time, or both, as the Supervising Professional may determine.

Section 27 - Payments Withheld Prior to Final Acceptance of Work

The City may withhold or, on account of subsequently discovered evidence, nullify the whole or part of any certificate to the extent reasonably appropriate to protect the City from loss on account of:

- (1) Defective work not remedied;
- (2) Claims filed or reasonable evidence indicating probable filing of claims by other parties against the Contractor;
- (3) Failure of the Contractor to make payments properly to subcontractors or for material or labor;
- (4) Damage to another Contractor.

When the above grounds are removed or the Contractor provides a Surety Bond satisfactory to the City which will protect the City in the amount withheld, payment shall be made for amounts withheld under this section.

Section 28 - Contractor's Insurance

- (1) The Contractor shall procure and maintain during the life of this Contract, including the guarantee period and during any warranty work, such insurance policies, including those set forth below, as will protect itself and the City from all claims for bodily injuries, death or property damage that may arise under this Contract; whether the act(s) or omission(s) giving rise to the claim were made by the Contractor, any subcontractor, or anyone employed by them directly or indirectly. Prior to commencement of any work under this contract, Contractor shall provide to the City documentation satisfactory to the City, through City-approved means (currently myCOI), demonstrating it has obtained the required policies and endorsements. The certificates of insurance endorsements and/or copies of

policy language shall document that the Contractor satisfies the following minimum requirements. Contractor shall add registration@mycoitracking.com to its safe sender's list so that it will receive necessary communication from myCOI. When requested, Contractor shall provide the same documentation for its subcontractor(s) (if any).

Required insurance policies include:

- (a) Worker's Compensation Insurance in accordance with all applicable state and federal statutes. Further, Employers Liability Coverage shall be obtained in the following minimum amounts:

Bodily Injury by Accident - \$500,000 each accident
Bodily Injury by Disease - \$500,000 each employee
Bodily Injury by Disease - \$500,000 each policy limit

- (b) Commercial General Liability Insurance equivalent to, as a minimum, Insurance Services Office form CG 00 01 04 13 or current equivalent. The City of Ann Arbor shall be named as an additional insured. There shall be no added exclusions or limiting endorsements specifically for the following coverages: Products and Completed Operations, Explosion, Collapse and Underground coverage or Pollution. Further there shall be no added exclusions or limiting endorsements that diminish the City's protections as an additional insured under the policy. The following minimum limits of liability are required:

\$1,000,000 Each occurrence as respect Bodily Injury Liability or Property
Damage Liability, or both combined.
\$2,000,000 Per Project General Aggregate
\$1,000,000 Personal and Advertising Injury
\$2,000,000 Products and Completed Operations Aggregate, which,
notwithstanding anything to the contrary herein, shall be
maintained for three years from the date the Project is completed.

Is there a reason why this is highlighted green?

- (c) Motor Vehicle Liability Insurance, including Michigan No-Fault Coverages, equivalent to, as a minimum, Insurance Services Office form CA 00 01 10 13 or current equivalent. Coverage shall include all owned vehicles, all non-owned vehicles and all hired vehicles. The City of Ann Arbor shall be named as an additional insured. There shall be no added exclusions or limiting endorsements that diminish the City's protections as an additional insured under the policy. Further, the limits of liability shall be \$1,000,000 for each occurrence as respects Bodily Injury Liability or Property Damage Liability, or both combined.

- (d) Umbrella/Excess Liability Insurance shall be provided to apply excess of the Commercial General Liability, Employers Liability and the Motor Vehicle coverage enumerated above, for each occurrence and for aggregate in the amount of \$1,000,000.

- (2) Insurance required under subsection (1)(b) and (1)(c) above shall be considered primary as respects any other valid or collectible insurance that the City may possess, including any self-insured retentions the City may have; and any other insurance the City does possess shall be considered excess insurance only and shall not be required to contribute

with this insurance. Further, the Contractor agrees to waive any right of recovery by its insurer against the City for any insurance listed herein.

- (3) Insurance companies and policy forms are subject to approval of the City Attorney, which approval shall not be unreasonably withheld. Documentation must provide and demonstrate an unconditional and un-qualified 30-day written notice of cancellation in favor of the City of Ann Arbor. Further, the documentation must explicitly state the following: (a) the policy number(s); name of insurance company(s); name and address of the agent(s) or authorized representative(s); name(s), email address(es), and address of insured; project name; policy expiration date; and specific coverage amounts; (b) any deductibles or self-insured retentions which may be approved by the City, in its sole discretion; (c) that the policy conforms to the requirements specified Contractor shall furnish the City with satisfactory certificates of insurance and endorsements prior to commencement of any work. Upon request, the Contractor shall provide within 30 days a copy of the policy(ies) and all required endorsements to the City. If any of the above coverages expire by their terms during the term of this Contract, the Contractor shall deliver proof of renewal and/or new policies and endorsements to the Administering Service Area/Unit at least ten days prior to the expiration date.
- (4) Any Insurance provider of Contractor shall be authorized to do business in the State of Michigan and shall carry and maintain a minimum rating assigned by A.M. Best & Company's Key Rating Guide of "A-" Overall and a minimum Financial Size Category of "V". Insurance policies and certificates issued by non-authorized insurance companies are not acceptable unless approved in writing by the City.
- (5) City reserves the right to require additional coverage and/or coverage amounts as may be included from time to time in the Detailed Specifications for the Project.
- (6) The provisions of General Condition 28 shall survive the expiration or earlier termination of this contract for any reason.

Section 29 - Surety Bonds

Bonds will be required from the successful bidder as follows:

- (1) A Performance Bond to the City of Ann Arbor for the amount of the bid(s) accepted;
- (2) A Labor and Material Bond to the City of Ann Arbor for the amount of the bid(s) accepted.

Bonds shall be executed on forms supplied by the City in a manner and by a Surety Company authorized to transact business in Michigan and satisfactory to the City Attorney.

Section 30 - Damage Claims

The Contractor shall be held responsible for all damages to property of the City or others, caused by or resulting from the negligence of the Contractor, its employees, or agents during the progress of or connected with the prosecution of the work, whether within the limits of the work or elsewhere. The Contractor must restore all property injured including sidewalks, curbing, sodding, pipes, conduit, sewers or other public or private property to not less than its original condition with new work.

Section 31 - Refusal to Obey Instructions

If the Contractor refuses to obey the instructions of the Supervising Professional, the Supervising Professional shall withdraw inspection from the work, and no payments will be made for work performed thereafter nor may work be performed thereafter until the Supervising Professional shall have again authorized the work to proceed.

Section 32 - Assignment

Neither party to the Contract shall assign the Contract without the written consent of the other. The Contractor may assign any monies due to it to a third party acceptable to the City.

Section 33 - Rights of Various Interests

Whenever work being done by the City's forces or by other contractors is contiguous to work covered by this Contract, the respective rights of the various interests involved shall be established by the Supervising Professional, to secure the completion of the various portions of the work in general harmony.

The Contractor is responsible to coordinate all aspects of the work, including coordination of, and with, utility companies and other contractors whose work impacts this project.

Section 34 - Subcontracts

The Contractor shall not award any work to any subcontractor without prior written approval of the City. The approval will not be given until the Contractor submits to the City a written statement concerning the proposed award to the subcontractor. The statement shall contain all information the City may require.

The Contractor shall be as fully responsible to the City for the acts and omissions of its subcontractors, and of persons either directly or indirectly employed by them, as it is for the acts and omissions of persons directly employed by it.

The Contractor shall cause appropriate provisions to be inserted in all subcontracts relative to the work to bind subcontractors to the Contractor by the terms of the General Conditions and all other contract documents applicable to the work of the subcontractors and to give the Contractor the same power to terminate any subcontract that the City may exercise over the Contractor under any provision of the contract documents.

Nothing contained in the contract documents shall create any contractual relation between any subcontractor and the City.

Section 35 - Supervising Professional's Status

The Supervising Professional has the right to inspect any or all work. The Supervising Professional has authority to stop the work whenever stoppage may be appropriate to insure the proper execution of the Contract. The Supervising Professional has the authority to reject all work and materials which do not conform to the Contract and to decide questions which arise in the execution of the work.

The Supervising Professional shall make all measurements and determinations of quantities. Those measurements and determinations are final and conclusive between the parties.

Section 36 - Supervising Professional's Decisions

The Supervising Professional shall, within a reasonable time after their presentation to the Supervising Professional, make decisions in writing on all claims of the City or the Contractor and on all other matters relating to the execution and progress of the work or the interpretation of the contract documents.

Section 37 - Storing Materials and Supplies

Materials and supplies may be stored at the site of the work at locations agreeable to the City unless specific exception is listed elsewhere in these documents. Ample way for foot traffic and drainage must be provided, and gutters must, at all times, be kept free from obstruction. Traffic on streets shall be interfered with as little as possible. The Contractor may not enter or occupy with agents, employees, tools, or material any private property without first obtaining written permission from its owner. A copy of the permission shall be furnished to the Supervising Professional.

Section 38 - Lands for Work

The Contractor shall provide, at its own expense and without liability to the City, any additional land and access that may be required for temporary construction facilities or for storage of materials.

Section 39 - Cleaning Up

The Contractor shall, as directed by the Supervising Professional, remove at its own expense from the City's property and from all public and private property all temporary structures, rubbish and waste materials resulting from its operations unless otherwise specifically approved, in writing, by the Supervising Professional.

Section 40 - Salvage

The Supervising Professional may designate for salvage any materials from existing structures or underground services. Materials so designated remain City property and shall be transported or stored at a location as the Supervising Professional may direct.

Section 41 - Night, Saturday or Sunday Work

No night or Sunday work (without prior written City approval) will be permitted except in the case of an emergency and then only to the extent absolutely necessary. The City may allow night work which, in the opinion of the Supervising Professional, can be satisfactorily performed at night. Night work is any work between 8:00 p.m. and 7:00 a.m. No Saturday work will be permitted unless the Contractor gives the Supervising Professional at least 48 hours but not more than 5 days notice of the Contractor's intention to work the upcoming Saturday.

Section 42 - Sales Taxes

Under State law the City is exempt from the assessment of State Sales Tax on its direct purchases. Contractors who acquire materials, equipment, supplies, etc. for incorporation in City projects are not likewise exempt. State Law shall prevail. The Bidder shall familiarize itself with the State Law and prepare its Bid accordingly. No extra payment will be allowed under this Contract for failure of the Contractor to make proper allowance in this bid for taxes it must pay.

Section 43

CONTRACTOR'S DECLARATION

I hereby declare that I have not, during the period _____, 20___, to _____, 20___, performed any work, furnished any materials, sustained any loss, damage or delay, or otherwise done anything in addition to the regular items (or executed change orders) set forth in the Contract titled _____, for which I shall ask, demand, sue for, or claim compensation or extension of time from the City, except as I hereby make claim for additional compensation or extension of time as set forth on the attached itemized statement. I further declare that I have paid all payroll obligations related to this Contract that have become due during the above period and that all invoices related to this Contract received more than 30 days prior to this declaration have been paid in full except as listed below.

There is/is not (Contractor please circle one and strike one as appropriate) an itemized statement attached regarding a request for additional compensation or extension of time.

Contractor

Date

By _____
(Signature)

Its _____
(Title of Office)

Past due invoices, if any, are listed below.

STANDARD SPECIFICATIONS

All work under this contract shall be performed in accordance with the Public Services Department Standard Specifications in effect at the date of availability of the contract documents stipulated in the Bid. All work under this Contract which is not included in these Detailed Specifications, or which is performed using modifications to these Standard Specifications, shall be performed in accordance with the Standard Specifications included in these contract documents.

Chris – I prefer that the Detailed Specs take precedence over the AA Standard Specs. Standard Specifications are available online:

<http://www.a2gov.org/departments/engineering/Pages/Engineering-and-Contractor-Resources.aspx>

DETAILED SPECIFICATIONS

SECTION 01000

GENERAL SPECIFICATIONS

1.1 WORKING SPACE

- A. The contractor shall interfere as little as possible with traffic and in all cases shall confine the work operations to the minimum space possible.
- B. Stockpiling of construction material and equipment will be permitted as necessary, but in no case shall traveled roadways, driveways, or entrances be unduly obstructed.
- C. Should storage areas be desired on private property, the Contractor may obtain such space on privately owned property at his own expense, by agreement with the property owner thereof. The Contractor shall provide the Owner with a copy of the written permission from the private property owner prior to occupying the property.
- D. Construct and maintain temporary roads accessing public thoroughfares to serve construction area.
- E. Provide and maintain access to fire hydrants, free of obstructions.
- F. Provide means of removing mud from vehicle wheels before entering streets.

1.2 LOCATING WORK

- A. The contractor shall accurately locate the work from reference points established by the Owner along the surface of the ground and the line of work. For sewers, "cut sheets" will be furnished by the Owner. Reference points shall be protected and preserved by the contractor.

1.3 SOIL CONDITIONS

- A. The contractor, as such and as bidder, shall make his own determination as to soil and/or rock conditions and shall complete the work in whatever material and under whatever conditions may be encountered or created, without extra cost to the owner. This shall apply whether or not borings are shown on the drawings.
- B. The owner does not guarantee that the ground encountered during construction will conform with any boring information furnished herein.
- C. The Owner and Engineer may have been involved in the design, construction observation, and/or construction of other underground projects in the area of the proposed construction. The observation field reports, soil reports, and any soil information connected with these projects are available for review by the prospective bidders.
- D. See Appendix I for geotechnical report

1.4 ROAD PERMITS

- A. The contractor shall obtain any necessary construction permits required of contractors for work within public streets, highways, roads, or alleys. The cost of construction permits, including, but not limited to, inspection fees, application fees, and/or review fees that may be required in connection with such permits, shall be at the Contractor's expense. Construction operations shall be conducted in accordance with provisions of such permits, including tunneling of pavements where required. The cost of any required bonds shall be included in the cost of the work as bid.

1.5 ROAD DETOURS

- A. The contractor shall provide and maintain all temporary roadways as required for work operations or as required under "Road Permits" or otherwise specified or shown on the drawings at no extra cost to the Owner.

1.6 PROTECTION OF THE PUBLIC

- A. The contractor shall provide sufficient barricades, guard railings, fencing, advance construction signing, coverings or other means to protect the public from injury due to the work operations, including completed or uncompleted work, at all times until acceptance of the work by the Owner at no extra cost to the Owner.

1.7 BARRICADES AND PROTECTION

- A. The contractor shall provide and maintain in good repair, all barricades, guard railings, etc., as required for the protection of the workers, the Owner's employees and employees of Owner's agent in strict compliance with state and local requirements.
- B. At dangerous points throughout the work, the contractor shall provide and maintain guard rails, colored lights, and flags. All possible precautions shall be taken to protect the workers from injury at no extra cost to the Owner.

1.8 FENCING

- A. Provide fencing around construction sites and equip as needed with vehicular and pedestrian gates with locks as shown on the Contract Drawings.

1.9 MAINTENANCE OF TRAFFIC

- A. During the progress of the work, the contractor shall accommodate both vehicular and pedestrian traffic as provided in these specifications and as indicated on the drawings. In the absence of specific requirements, traffic shall be maintained in accordance with the current edition of the Michigan Manual of Uniform Traffic Control Devices. Access to fire hydrants and water valves shall always be maintained. The contractor's truck and equipment operations on public streets shall be governed by County regulations, all local traffic ordinances, and regulations of the Fire and Police Department.
- B. Small street openings necessary for manholes, alignment holes, sewer connections, etc. will be permitted. Such holes shall not be open longer than necessary and shall be protected and any traffic detouring necessary shall be done to the satisfaction of the Owner. Wherever possible,

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small openings shall be covered with steel plates at pavement level secured in place during periods that work is not being performed at no extra cost to the Owner.

- C. Where streets are partially obstructed, the contractor shall place and maintain temporary driveways, ramps, bridges and crossings which in the opinion of the Owner are necessary to accommodate the public at no extra cost to the Owner. In the event of the contractor's failure to comply with the foregoing provisions, the Owner may, with or without notice, cause the same to be done and deduct the cost of such work from any monies due or to become due the contractor under this contract. However, the performance of such work by the Owner, or at his insistence, shall serve in no way to release the contractor from his liability for the safety of the traveling public.
- D. The contractor shall provide flagmen, warning lights, signs, fencing and barricades necessary to direct and protect vehicular and pedestrian traffic at no extra cost to the Owner.
- E. The contractor shall inform the local fire department in advance of work operations of street obstructions and detours, so that the fire department can set up plans for servicing the area in case of an emergency. The governing police department and the owner shall be notified at least one week prior to obstructing any street.

1.10 TRAFFIC REGULATION

- A. The Contractor's trucks and equipment operations shall be governed by all applicable ordinances; the rules and regulations of the Fire, Police, Transportation Departments; and the requirements of any other authority having jurisdiction. Flagman, warning lights, traffic signs, cones, and barricades shall be provided by the Contractor as necessary to direct and protect vehicular and pedestrian traffic at all locations of construction operations.
- B. The Contractor shall be responsible for obtaining approvals and securing permits from all authorities having jurisdiction over work in rights-of-way.
- C. The Contractor shall notify the Engineer, the local police and fire departments, all other interested local authorities, and the residents of all affected streets five days prior to any street closures.
- D. The Contractor shall provide and maintain all temporary facilities required. These shall include but not be limited to facilities necessary to maintain pedestrian and vehicular traffic access through the area or to adjacent properties and to provide unobstructed access to fire hydrants and water and gas valves. The Contractor shall provide all barriers, lights, warning flags and signals, and the like that the Engineer or other authorities may require to accommodate and protect the public.
- E. Should the Contractor fail to promptly provide or neglect to maintain the required temporary facilities or be dilatory in carrying out specific instruction to the Engineer, the Owner may with or without notice to the Contractor take such remedial measures deemed necessary and charge the Contractor with any costs incurred therefor. Any such action, however, shall in no way serve to release the Contractor from his general or particular liability for the safety of the traveling public or the protection of property.
- F.

1.11 PRESERVATION OF TREES

- A. The contractor shall protect and preserve all trees along the line of work, and will be held responsible for any damage to trees. Where necessary to preserve a tree and its main roots, the contractor shall tunnel under such tree. Where specifically called for on the drawings, the contractor shall remove trees completely, including stumps and main roots.
- B. Where tunneling is not required for trees close to the trench and root trimming is necessary, the contractor shall hand trench ahead of the machine digging and cut all roots cleanly to minimize damage to the roots.
- C. Tree branches shall be tied back to protect them from the contractor's machinery.
- D. When a tree is removed by the contractor for his convenience and with the permission of the Owner and the adjacent property owner (where required), the contractor shall furnish one three (3) inch dia. tree for every six (6) inches of diameter of the tree removed. The species shall be as directed by the Owner. All trees installed shall be guaranteed to grow for a period of one (1) year.
- E. The contractor will receive no extra compensation for preservation of trees or for their removal and replacement where called for, and the cost of all work involved shall be included in the unit price bid or at no extra cost to the owner.

1.12 REPLACEMENT OF SHRUBBERY

- A. The contractor shall protect and/or replace all shrubbery damaged or destroyed by operations under this contract at no extra cost to the owner.

1.13 EXISTING STRUCTURES AND UTILITIES

- A. Certain underground structures and utilities have been shown as an aid to the contractor, but the owner does not guarantee their location or that other underground structures or utilities may not be encountered.

1.14 PROTECTION OF PROPERTY AND SURVEY MONUMENTS

- A. Before any monuments or stakes marking the boundaries of property along or near the work are removed or disturbed, notify the Engineer in sufficient time so that they can be properly located and reset. Contractor shall pay all costs incurred in connection therewith.
- B. All precautions shall be taken to avoid disturbance of permanent survey monuments of any city, county, state, or federal authority; and when any of these are disturbed or destroyed, the Contractor shall restore them to the satisfaction of such authority and shall pay all costs incurred by such authority in connection therewith.

1.15 PUBLIC AND PRIVATE UTILITIES

- A. Utilities
 - 1. The Contractor must provide adequate protection for water, sewer, gas, telephone, TV cable, or any other public or private utilities encountered. The Contractor will be held responsible for any damages to such utilities arising from his operation.

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2. When it is apparent that construction operations may endanger the foundations of any utility conduit, or the support of any structure, the contractor shall notify the utility owner of this possibility and shall take steps as may be required to provide temporary bracing or support of conduit or structures.
3. In all cases where permits or inspection fees are required by utilities in connection with changes to or temporary support of their conduits, the contractor shall secure such permits and pay all inspection fees.
4. Where it is necessary in order to carry out the work, that a pole, electric or telephone, be moved to a new location, or moved and replaced after construction, the contractor shall arrange for the moving of such pole or poles, and the lines thereof, and shall pay any charges therefor.
5. Where it is the policy of any utility owner to make repairs to damaged conduit or other structures, the contractor shall cooperate to the fullest extent with the utility and shall see that construction operations interfere as little as possible with the utilities operations. The contractor shall pay any charges for these repairs.

B. Existing Sewer Facilities

1. Existing sewers or drains may be encountered along the line of work. In all such cases, the contractor shall perform the work in such a manner that sewer service will not be interrupted. and shall make all temporary provisions to maintain sewer service as incidental to the work as bid.
2. Unless otherwise indicated on the drawings, the contractor shall replace any disturbed sewer or drain, or relay same at a new grade and/or location to be established by the Owner such that sufficient clearance for the sewer will be provided.
3. The contractor will receive no extra compensation for replacement or relocation of sewers or drains encountered, or for relaying at a new grade where called for by the drawings unless a separate bid item has been included in the proposal.

C. Existing Water Facilities

1. Where existing water mains are encountered in the work, they shall be maintained in operation. If necessary, they shall be re-laid using ductile iron pipe of the type and with joints as specified within the current water main specifications of the governmental agency controlling said utility.
2. The contractor will receive no extra compensation for the relaying and/or lowering or raising of water mains or water service leads, except where a separate bid item has been included in the proposal.

D. Existing Gas Facilities

1. Where existing gas mains and services are encountered, the contractor shall arrange with the gas company for any necessary relaying, and shall pay for the cost of such work unless otherwise provided.

1.16 PUMPING, BAILING AND DRAINING

- A. The contractor shall provide and maintain adequate pumping and drainage facilities for removal and disposal of water from trenches or other excavations.
- B. Where the work is in ground containing an excessive amount of water, the contractor shall provide, install, maintain, and operate suitable deep wells or well points, connecting manifolds and reliable pumping equipment to operate same to insure proper construction of the work. Alternate dewatering methods may be implemented if approved by the Owner.

- C. Drainage or discharge lines shall be connected to adjacent public storm water drains or extended to nearby water courses wherever possible. In any event, all pumping and drainage shall be done without damage to any highway or other property, public or private, and without interference with the rights of the public or private property owners and in accordance with the MDEQ and local requirements for soil erosion and sedimentation control.
- D. The contractor shall receive no extra compensation for providing, maintaining or operating any dewatering or drainage facilities.

1.17 GROUND AND SURFACE WATER CONTROL

- A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment. All water from whatever sources entering the work during any stage of construction shall be promptly removed and disposed.
- B. All pumping and drainage shall be done without damage to property or structures and without interference with the rights of the public, owners of private property, pedestrians or vehicular traffic, or the work of other contractors. Dewatering shall be done in such a manner that soil under or adjacent to existing structures shall not be disturbed, removed, or displaced.

1.18 SHEETING, SHORING AND BRACING

- A. Where necessary in order to construct the work called for by the contract, to insure the safety of the workers, or to protect other things of value, the contractor shall use and, if necessary, leave in place, such sheeting, shoring, and bracing as is needed to carry out the work or to adequately insure the stability of such work, or to insure the safety of the workers and/or to protect adjoining things of value. The contractor will receive no extra compensation for sheeting, shoring, or bracing, whether removed or left in place.

1.19 DISPOSAL OF EXCAVATED MATERIAL

- A. With the exception of an amount of excavated materials sufficient for backfilling and construction of fills, as called for on the drawings, all broken concrete, stone, and excess excavated materials shall be disposed of from the site by the contractor. The contractor will be required to obtain his own disposal ground, and will receive no extra compensation for disposing of any of the excess materials.

1.20 DISPOSAL OF WASTE MATERIALS

- A. Unless otherwise directed by the owner, all waste materials and debris resulting from the construction work shall be removed from the premises at no extra cost to the owner.
- B. The contractor shall, at all times, keep the premises free from accumulations of waste material or debris caused by his employees or work, and shall remove same when necessary or required by the owner.

1.21 PROGRESS CLEANING AND WASTE REMOVAL

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

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- B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.
- C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.
- D. Collect and remove waste materials, debris, and rubbish from site weekly and dispose off-site.

1.22 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, materials, prior to Substantial Completion inspection.
- B. Remove underground installations to a minimum depth of 2 feet. Grade site as indicated.
- C. Clean and repair damage caused by installation or use of temporary work.
- D. Restore existing and permanent facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

1.23 TUNNELING

- A. The contractor shall construct the work in tunnel where shown on the drawings or required by permits, and at other locations may, at his option, construct the work in tunnel where it crosses existing roadways, public and private utilities, walks or other structures. Tunnel work shall be constructed in accordance with the drawings and specifications, "Road Permit" requirements, or as otherwise noted on the drawings at no extra cost to the owner.

1.24 COMPRESSED AIR

- A. The contractor shall provide compressed air as required for the work at no extra cost to the owner.

1.25 FIRST AID FACILITIES

- A. Provide complete first aid kit fully stocked at all times. Replenish as needed.
- B. Post safety related phone numbers (Police, fire, EMS, hospital, etc.)

1.26 INSPECTION OF PREMISES

- A. The bidder shall visit the premises and thoroughly acquaint himself with the conditions to be encountered in the installation of the work shown on the drawings and described in the specifications, as no extras will be allowed to cover work which he has not included in his tender due to his failure to inspect the premises.

1.27 SCHEDULE OF OPERATIONS

- A. The contractor shall submit, for the owner's review and approval, a schedule of his proposed operations. The contractor's schedule shall be complete and shall show in detail the manner in which he proposed to complete the work under this contract.

1.28 ORDINANCES AND CODES

- A. All work shall be executed and inspected in accordance with all local and state rules and regulations and all established codes applicable thereto and shall conform in all respects to the requirements of all authorities having jurisdiction thereover.
- B. Should any change in the contract plans and/or specifications be required to comply with local regulations, the contractor shall notify the owner in accordance with Specification 000_ITB pages IB-1 thru 6 – Instructions to Bidders. After entering into contract, the contractor will be held to complete all work necessary to meet the local requirements without extra expense to the owner.
- C. Where the work required by the drawings and specifications is above the standard required, it shall be done as shown or specified.

1.29 TRAFFIC CONTROL

- A. During construction the contractor shall control traffic in accordance with the current edition of the Michigan Manual of Uniform Traffic Control Devices issued by the Michigan Department of Transportation.

1.30 DUST CONTROL

- A. The contractor shall provide adequate measures to control dust caused by his operation. The methods employed, and frequency of application shall be as approved and directed by the Owner.

1.31 INCONVENIENCES

- A. The contractor shall at all times be aware of inconveniences caused to the abutting property owners and general public. Where undue inconveniences are not remedied by the contractor, the municipality, upon four hours notice, reserves the right to perform the necessary work and to have the owner deduct the cost thereof from the money due or to become due to the contractor.

1.32 PROTECTION OF INSTALLED WORK

- A. Protect installed Work and provide special protection where specified in individual specification sections.
- B. Provide temporary and removable protection for installed Products. Control activity in immediate work area to prevent damage.
- C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- D. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- E. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

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- F. Prohibit traffic from landscaped areas.
- G. Prohibit construction traffic from utilizing permanent site access bridge.

END OF SECTION

SECTION 01005

ADMINISTRATIVE PROVISIONS

PART 1 GENERAL

1.1 REQUIREMENTS INCLUDED

- 1.02 Related Sections
- 1.03 Summary of work.
- 1.04 Work sequence.
- 1.05 Alternatives.
- 1.06 Coordination
- 1.07 Cleanliness of the work and streets.
- 1.08 Regulatory requirements.
- 1.09 Alterations of existing water mains and services.
- 1.10 Satisfaction of Claims
- 1.11 Fire protection.
- 1.12 Chemicals.
- 1.13 Historical specimens.
- 1.14 Abbreviations.
- 1.15 References.

1.2 RELATED REQUIREMENTS

- A. Section 000_ITB – Invitation to Bid
- B. Section 01000 - General Specifications.
- C. Section 01310 - Progress Schedules.
- D. Section 01700 - Contract Closeout.
- E. Section 02030 - Sequence of Construction and Special Project Requirements.

1.3 COORDINATION

- A. Contract Documents:
 - 1. It is not the intent nor shall it be so construed that work included in any one Section of the Specifications must be performed by a particular trade or by subcontract. The work to be performed by a particular trade is not necessarily restricted to that of any one Section.
 - 2. Any item mentioned under any heading must be supplied even though it is not called for again under the heading for the respective work.
- B. Existing Facilities:
 - 1. All existing facilities and operations shall be uninterrupted by the Contractor's performances unless otherwise allowed in the Contract Documents.
 - 2. All proposed interruptions or tie-ins to existing facilities or utilities or other activities affecting the operations shall be scheduled.
 - 3. The Engineer shall approve the scheduling of all such activities.

1.4 CLEANLINESS OF THE WORK AND STREETS

- A. The work itself, and all public and private property used therewith, shall be kept in a neat orderly condition at all times. Excess excavation, waste and rejected materials, rubbish, and debris shall not be allowed to accumulate. The newly constructed work shall be cleared of all temporary construction of facilities when such are entirely free of all debris and the premises left in a condition that will not be susceptible to soil erosion and that will not create a situation problem.
- B. Trucks hauling loose materials to or from the site shall be tightly covered and their loads shall be trimmed to prevent spillage on the public streets or roads. This requirement likewise applies to suppliers making deliveries to the site. The Contractor shall promptly clean streets or roads dirtied by any cause arising from his operations or that of his Subcontractors or his suppliers. Should the Contractor fail to maintain proper street or road cleanliness, the Owner will take necessary steps to perform such cleaning and will charge the Contractor for all cost thereof.
- C. The Contractor shall control dust from his operations to meet the requirements of the jurisdictional authorities. Control measures shall include but are not limited to sprinkling, applying calcium chloride, wheel washing, street sweeping, street washing, load covering, and the like.

1.5 REGULATORY REQUIREMENTS

- A. The Contractor shall apply for inspection of the work to any and all local, state, public and/or private utilities or national authorities having jurisdiction and deliver to the Engineer all required certificates of approval of such authorities.
- B. All costs including temporary improvements, and the restoration of existing improvements (e.g. sidewalks, pavements, soil erosion and sedimentation control, landscaping, etc.) to the satisfaction of the authority having jurisdiction in each case shall be included in the Contract Price.

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1.6 ALTERATIONS OF EXISTING WATER MAINS OR SERVICES

- A. The cutting, reconstructing, or relocating of any existing water mains or water services connections necessitated to permit construction of the work under this Contract shall be performed by the contractor, and the cost of all work and material including inspection and permits shall be included in the Contract bid price.
- B. The Contractor shall not operate any valves or switches. All valves and switches shall be operated by the Owner's personnel only.
- C. If the Contractor finds it necessary to shut down any existing water mains in services, he shall contact the Engineer and they will then negotiate the best time for shut down mains. A minimum of three (3) days notice must be given.
- D. The Contractor shall receive no extra payment on account of the times when such shut offs and alterations have to be made or on account of delays incurred in conjunction with such alterations.

1.7 SATISFACTION OF CLAIMS

- A. Before final payment can be made, the Contractor shall furnish satisfactory evidence that all claims for damage have been legally settled, or sufficient funds to cover such claims have been placed in escrow, or that an adequate bond to cover such claims has been obtained to secure payment therewith interest.
- B. In the event that any Contractor has trespassed upon private property in the prosecution of the work of this contract, the Owner may withhold payment for the value of such work in or on the property, but in any case no less than a sum of \$500 for each property trespassed until the Contractor has secured a release from the property owner upon whose property the trespass was committed.

1.8 FIRE PROTECTION

- A. The Contractor shall take all necessary precautions to prevent fires and shall provide adequate equipment for extinguishing fires. No burning of trash or debris will be permitted.
- B. When fire or explosion hazards are created in the vicinity of the work as a result of the locations of fuel tanks or similar hazardous utilities or devices, the Contractor shall immediately alert the local Fire Marshal, the Engineer, and the Owner. The Contractor shall exercise all safety precautions and shall comply with all instructions issued by the Fire Marshal and shall cooperate with the Owner of the tank or device to prevent the occurrence of fire or explosion.

1.9 CHEMICALS

- A. All chemicals used during construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, or reactant of other classification, must show approval of the EPA, USDA, or both. Use of all such chemicals and disposal of residues shall be in strict conformance with all applicable law, rules, and regulations.

1.10 HISTORICAL SPECIMENS

- A. Any and all specimens of historical or scientific value or interest encountered in the Work shall be preserved and delivered to the Engineer.

1.11 ABBREVIATIONS

- A. The following listed letters or abbreviations wherever they appear in the Contract shall mean and be interpreted as indicated below:

A.A.S.H.O.	- American Association of State Highway Officials
A.C.I.	- American Concrete Institute
A.G.M.A.	- American Gear Manufacturers Association
A.H.D.G.A.	- American Hot Dip Galvanizers Association
A.I.A.	- American Institute of Architects
A.I.S.C.	- American Institute of Steel Construction
A.I.S.I.	- American Iron and Steel Institute
A.M.C.A.	- Air Moving and Conditioning Association
A.N.S.I.	- American National Standards Institute
A.S.C.E.	- American Society of Civil Engineers
A.S.H.R.A.E.	- American Society of Heating, Refrigeration and Air Conditioning Engineers.
A.S.M.E.	- American Society of Mechanical Engineers
A.S.T.M.	- American Society for Testing and Materials
A.W.G.	- American Wire Gauge
A.W.S.	- American Welding Society
A.W.W.A.	- American Water Works Association
D.P.W.	- Department of Public Works - City of Detroit
D.W.S.D.	- Detroit Water & Sewerage Department
Fed. Spec.	- Federal Specification, Federal (of F.S.) Supply Service, General Services Administration, U.S. Government
I.E.E.E.	- Institute of Electrical and Electronics Engineers
I.P.C.E.A.	- Insulated Power Cable Engineers Association
M.D.O.T.	- Michigan Department of Transportation (Formerly M.D.S.H. & T)
M.I.O.S.H.A.	- Michigan Occupational Safety & Health Act
N.B.S.	- National Bureau of Standards
N.C.P.I.	- National Clay Pipe Institute
N.E.C.	- National Electrical Code
N.E.M.A.	- National Electrical Manufacturers Association
N.F.P.A.	- National Fire Protection Association
O.S.H.A.	- Occupational Safety & Health Administration
S.D.I.	- Steel Deck Institute
S.J.I.	- Steel Joist Institute
S.S.P.C.	- Steel Structures Painting Council
U.L.	- Underwriters Laboratories

1.12 REFERENCES

- A. Specifications by Reference:
 - 1. Where reference is made in the specifications to specifications or standards of any technical society, association, governmental agency, etc., it is understood and agreed

that such specifications or standards are as much a part of the specifications as though fully repeated therein.

B. Materials by Reference:

1. A material included in more than one section of the specifications will be specified in detail in only one of the Sections.
2. In other sections, the material is specified by reference to the section containing the specifications for the same material, and such specifications shall be considered as much a part of the other sections as if they were therein repeated in full.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01039

COORDINATION AND MEETINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Related Sections
- B. Coordination.
- C. Pre-Bid Meeting.
- D. Preconstruction Meeting.
- E. Progress Meetings.
- F. Preinstallation Meetings.

1.2 RELATED SECTIONS

- A. Section 000 – ITB (Instructions for Bidders).
- B. Section 01005 - Administration Provisions.
- C. Section 01300 - Submittals.
- D. Section 01310 - Progress Schedules.

1.3 COORDINATION

- A. Coordinate scheduling, submittals, and Work of the various sections of the Project Manual to assure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- B. Verify utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- C. Coordinate space requirements and installation of mechanical and electrical work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with line of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- D. Coordinate completion and clean up of Work of separate sections in preparation for Substantial Completion and for portions of Work designated for Owner's occupancy.

- E. After Owner occupancy of premises, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

1.4 PRE-BID MEETING

- A. Engineer will schedule a meeting as noted in the Information for Bidders.
- B. Attendance Required: Owner, Engineer, and Bidders.
- C. Attendance Requested: Regulatory Agencies, Utility Representatives.
- D. Agenda:
 - 1. Review of Permits Required.
 - 2. Review of Special Project Requirements.
 - 3. Regulatory requirements affecting the project.
 - 4. Review of Contract Documents.
 - 5. Critical work sequencing.
 - 6. Use of premises by Owner and Contractors
 - 7. Construction facilities and controls provided by Owner.
 - 8. Temporary utilities provided by Contractor and by Owner.
 - 9. Survey and layout.
 - 10. Security and housekeeping procedures.
 - 11. Responsibility for testing.
- E. Record minutes and distribute copies within two days after meeting to participants, with one copy to all participants, and those affected by decisions made.

1.5 PRECONSTRUCTION MEETING

- A. Engineer will schedule a meeting prior to issuing Notice of Award.
- B. Attendance Required: Owner, Engineer, major subcontractors and Contractor.
- C. Agenda:
 - 1. Review of Execution of Owner-Contractor Agreement.
 - 2. Review of Regulatory requirements affecting the project.
 - 3. Distribution of Control Documents.
 - 4. Submission of progress construction schedule.
 - 5. Designation of personnel representing the parties in Contract, and the Engineer.
 - 6. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
 - 7. Critical work sequencing.
 - 8. Use of premises by Owner and Contractor
 - 9. Construction facilities and controls provided by Owner.
 - 10. Mobilization
 - 11. Project Coordination
 - 12. Temporary utilities provided by Contractor and Owner.
 - 13. Survey and layout.
 - 14. Security and housekeeping procedures.

15. Procedures for testing.
 16. Procedures for maintaining record documents.
- D. Record minutes and distribute copies within two days after meeting to participants, with one copy to all participants, and those affected by decisions made.

1.6 PROGRESS MEETINGS

- A. The Engineer will schedule and administer meetings throughout progress of the Work at maximum monthly intervals.
- B. Engineer will make arrangements for meetings, prepare agenda with copies for participants, and preside at meetings.
- C. Attendance Required: Job superintendent, major Subcontractors and Suppliers, Owner, Engineer, as appropriate to agenda topics for each meeting.
- D. Agenda:
1. Review minutes of previous meetings.
 2. Review of Work progress.
 3. Field observations, problems, and decisions.
 4. Identification of problems which impede planned progress.
 5. Review of submittals schedule and status of submittals.
 6. Review of on site and off-site fabrication and delivery schedules.
 7. Maintenance of progress schedule.
 8. Corrective measures to regain projected schedules.
 9. Planned progress during succeeding work period.
 10. Coordination of projected progress.
 11. Maintenance of quality and work standards.
 12. Effect of proposed changes on progress schedule and coordination.

1.7 PREINSTALLATION MEETING

- A. When required in individual specification sections, convene a preinstallation meeting at work site prior to commencing work of the section.
- B. Require attendance of parties directly affecting, or affected by, work of the specific section.
- C. Notify Engineer four days in advance of meeting date.
- D. Prepare agenda and preside at meeting:
1. Review conditions of installation, preparation and installation procedures.
 2. Review coordination with related work.
- E. Record minutes and distribute copies within two days after meeting to participants, with copies to Engineer, Owner, participants, and those affected by decisions made.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01045
CUTTING AND PATCHING

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes the cutting, coring, patching and desired surface finish of penetrations, holes and openings in concrete slabs, pre-cast roof slabs and concrete or masonry walls for existing or new construction.

1.2 RELATED REQUIREMENTS

- A. Section 01300 – Submittals
- B. Division 03 – Concrete
- C. Division 04 – Masonry
- D. Section 15000 – General Mechanical
- E. Section 15600 – Ductwork and Accessories
- F. Section 16010 – General Electrical, Instrumentation, and Controls Requirements

1.3 SUBMITTALS

- A. Submit written request for approval in advance of cutting or alteration which affects:
 - 1. Structural integrity of any element of Project, including cutting or coring structural members.
 - 2. Integrity of weather exposed or moisture resistant element.
 - 3. Visual qualities of sight exposed elements.
 - 4. Work of Owner or separate Contractor.
- B. Include in request for approval:
 - 1. Location and description of affected Work.
 - 2. Field measurements relevant to the cutting, coring, or alteration.
 - 3. Description of proposed Work and Products to be used.
 - 4. Effect on work of Owner or separate Contractor.
 - 5. Written permission of affected separate Contractor.
 - 6. Desired date and time for when work will be executed.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Concrete and grout for patching shall be as specified in Divisions 03 and 04.

- B. Escutcheon plates are specified in Division 15.
- C. Materials or coatings for finishing patching shall be equal to those of adjacent construction. Where existing materials are no longer available, use materials with equivalent properties and that will provide the same appearance. The materials are to be approved by the Engineer prior to their use.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not perform Work until submittal request has been reviewed and approved by the Engineer.
- B. Examine existing conditions prior to commencing Work, including elements subject to damage or movement during cutting and patching.
- C. When required by the Engineer, identify reinforcing steel with non-destructive testing methods including pachometer or ground penetrating radar (GPR) technology. These tests will be performed by an independent contractor, paid under an allowance.
- D. When embedded electrical conduit is known or thought to existing in the concrete slab, contractor shall coordinate electrical shutdown with Owner and identify potential power source.
- E. After uncovering existing Work, assess conditions affecting performance of work.
- F. Beginning of cutting means acceptance of existing conditions.

3.2 PREPARATION

- A. Provide temporary supports to ensure structural integrity of the Work. Provide devices and methods to protect other portions of Project from damage.
- B. Provide protection from elements for areas which may be exposed by uncovering work, including protection from dust and water.
- C. When permitted, seal electrical components (MCCs, substations, panels, etc.) from dust intrusion during cutting and patching. Shut down equipment that requires ventilation during operation.
- D. Cores for segmented compressible links (link seal) shall be coordinated with pipe OD.

3.3 CUTTING

- A. Plan and execute cutting and fitting to minimize area of the Work. Do not overcut openings at corners.

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- B. Employ skilled and experienced installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.
- C. Cutting shall be performed with a concrete saw equipped with diamond saw blades of proper size. Provide for control of slurry generated by sawing operation on both sides of wall and from below if cutting a floor.
- D. Cutting shall be controlled to the depth required. Slabs on grade shall be cut such that any utilities buried below the slab shall not be cut.
- E. Where practical as determined by the Owner, the area to be repaired shall be saw cut on a specified line and depth, without cutting existing reinforcement, to provide a shoulder for repair material and eliminate "feather-edged" repairs.
- F. Adequate shoring of area to be cut shall be installed prior to start of cutting. Do not allow any concrete to fall onto adjacent surfaces or to the floor below. Check area during sawing operations for partial cracking and provide additional bracing as required to prevent a partial release of cut area during sawing operations.
- G. Saw cut concrete and masonry prior to breaking out sections.

3.4 CORING

- A. All coring shall be planned and executed in such a manner as to limit the extent of patching. Where identified on the Drawings, locate the reinforcement before coring to minimize cut-throughs.
- B. Coring shall be performed with an approved non-impact core drill with diamond core drill bits. All work shall be performed by specialty contractors skilled in this type of work.
- C. Size of cores shall be suitable for pipe, conduit, sleeves, equipment or mechanical seals to be installed. Size cores to minimize space to pipes, sleeves, ducts, conduit or other penetrations.
- D. Protect and secure all cores. Provide protection and containment below the area being drilled to catch the plug and contain liquid and slurry.

3.5 PATCHING

- A. Patching shall be performed to match existing surfaces to its original appearance.
- B. Patching material shall match the type and quality of material removed.
- C. Anchors and rebar shall be sufficiently removed such that patching adequately covers the steel.
- D. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed to include the joint between the existing material and the patch.

3.6 PROTECTION AND FINISHING

- A. Maintain areas free of water and/or remove slurry or tailings by containing via sand bagging the affected area, and wet vacuuming, diverting water to floor drain or other means suitable to the Owner.
- B. Provide devices and methods to protect other portions of project from damage.
- C. Provide protection from elements for that portion of the project which may be exposed by cutting and patching work.
- D. Equipment damaged during cutting and patching shall be replaced or repaired. The Contractor will be responsible for repair or replacement costs.
- E. Restore the surface to match the existing conditions.
- F. Repaint any damage to factory applied paint finishes using touch-up paint furnished by the equipment manufacturer.
- G. Facility equipment shall be protected against mechanical and water damage during cutting and patching. Provide protective covers or use other means such as temporary relocation to protect equipment that is at risk of damage from the cutting and patching.
- H. Provide protection for existing equipment, utilities and critical areas against water or other damage caused by drilling operation.

END OF SECTION

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SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1.1 SUMMARY OF WORK

- A. Submittals are required for all items incorporated into the Work
- B. Submittals for the Work include the following
 1. Contractual Requirements
 2. Construction Schedule
 3. Schedule of Values
 4. Shop Drawing Schedule
 5. Progress Meeting Submittals (see Section 01039)
 6. Construction Pay Applications including Certified Payroll
 7. Shop Drawings, Product Data, and Samples including Manufacturer's Certificates and Test Data (when required).
 8. Manufacturer's O & M Manuals
 9. Shut-down Schedule and Work Plans (when required)
 10. Equipment Installation Certification and Field Calibration Reports
 11. Maintenance Log
 12. Lists of Spare Parts
 13. Facility Start-up and Commissioning Documents
 14. As-Built Drawings
 15. Close-Out Documents

1.2 RELATED SECTIONS

- A. Specification 000_ITB pages IB-1 thru 6 – Instructions to Bidders
- B. Section 01039 – Coordination and Meetings
- C. Section 01310 - Construction Progress Schedules
- D. Section 01400 - Quality Control
- E. Section 01650 - Facility Start-up and Commissioning
- F. Section 01700 - Contract Closeout
- G. Section 01730 - Operation and Maintenance Data

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1.3 SCHEDULE FOR SUBMISSION

- A. Contractual Requirements such as bonds, insurance, etc., shall be submitted per ITB General Conditions.
- B. The Construction Schedule shall be submitted per Section and 01310.
- C. Schedule of Values and Schedule of Submittals shall be submitted within 20 days of the Notice to Proceed.
- D. Resubmit updated Schedule of Submittals, schedules, and logs at each Progress meeting. (see 01039)
- E. Shop Drawings, Product Data and Samples shall be submitted with sufficient time for Engineering review, modification, re-submittal, re-review, etc. until the submittals are approved.
- F. Manufacturer's Certificates and Test Data shall be submitted with the Shop Drawings or when performed but prior to shipping.
- G. Pay Applications shall be submitted monthly.
- H. Shut-Down Schedule Work Plan shall be submitted 10 days prior to shutdown.
- I. Maintenance Log shall be submitted one month prior to the first shipment of equipment and shall be updated and submitted monthly.
- J. Manufacturer's O&M Manuals shall be submitted prior to equipment shipping.
- K. List of Spare Parts shall be submitted 10 days prior to turnover.
- L. Facility Start-up and Commissioning documents shall be submitted in accordance with Section 01650.
- M. The Construction Schedule, Schedule of Values, and Schedule of Submittals will be reviewed by the Engineer. If rejected, these submittals must be revised and re-submitted until approval. The Engineer reserves the right to withhold the first Pay Application until approval.
- N. Record Drawings and Close-Out Documents shall be submitted per Section 01700.
- O. Schedule submittals to expedite the Project and deliver to the Engineer in a manner to allow sufficient time for review and processing by the Engineer so as to not cause delays in the Work. Coordinate submission of related items.
- P. The Submittals shall not relieve the Contractor of his obligation to comply with specification requirements for items not listed on the schedule. Nothing herein shall be construed as allowing additional time for completion of the project in the event one or more resubmittals are required.

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1.4 FORMAT

- A. Submit all submittals in .PDF format. In addition, provide the following:
1. Color charts on gloss paper or color palette
 2. Samples in actual format (bricks, block, etc.)
 3. Final O&M Manuals in paper in 3-ring binder per specification 01730.
 4. Layout drawings in AutoCad, when AutoCad files have been provided to the Contractor for use in shop drawing preparation
 5. Photos in .jpeg format.

1.5 SCHEDULE OF VALUES

- A. The Schedule of Values shall include quantities and unit prices from the Bid Form, and lump sum prices for all remaining work by the Engineer. The lump sum items shall be segregated such that no item has a value larger than two (2) percent of the Total Bid Price unless approved by the Engineer.
- B. Division 00 and 01 Costs.
1. The Schedule of Values shall include Bonds and Insurance, Mobilization, Demobilization, Submittals and Job-site Superintendent. Other job-wide costs can be included.
 2. Separate costs for Item 1.05 B. 1. can also be included for the major subcontractors.
 3. Manufacturer's Division 00 and 01 costs are to be included in the equipment, materials or products costs.
 4. Mob and De-mob costs shall be equal, and the superintendent payments shall be prorated.
- C. Other Costs:
1. Equipment and material costs can include installation and profit, however payment for stored equipment and materials will be based on invoiced costs.
 2. Shop drawing preparation can be paid up to 5% of the equipment price, upon shop drawing approval.
- D. If not separately identified as in 1.05 B., each item shall include its proportionate share of the Contractor's general operating charges such as profit, overhead, supervision, insurance, bond premiums, interest, equipment cost, depreciation and rental, contingencies, expendable tools, equipment and supplies.
- E. The total cost of the items and quantities the Contractor lists in the schedule of values shall equal the lump sum Contract Price established in the Bid Form.
- F. Where required, the Schedule of Values shall include a complete set of detailed work sheets on bid take off and bid summary covering estimated general conditions expense (field overhead, general overhead, profit mark ups and revisions leading to the final bid amount.
- G. When the Schedule of Values is approved by the Engineer, it shall become part of the Agreement and shall be used as the basis for Contractor progress payments, and to establish unit prices at which extra work may be authorized or deducted from the original Agreement.

1.6 SCHEDULE OF SUBMITTALS

- A. The detailed Schedule of Submittals shall include all submittal requirements, including shop drawings, Product Data, Samples, O&M Manuals, spare parts, maintenance log, training, start-up submittals (Section 01650), close-out, etc.
- B. The cloud-based Project Management submittals log once approved, can take the place Schedule of Submittals

1.7 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

- A. General
 - 1. The contract drawings and specifications are complete in all aspects of layout, type of equipment and materials. They do not serve as detailed fabrication, materials, or installation drawings, and the preparation of such submittals required or necessary for this purpose shall be the responsibility of the Contractor.
 - 2. Shop Drawings, Product Data, and Samples are required for all equipment, products, materials, hardware, fasteners, anchors, shims, or anything else incorporated permanently into the work, furnished or installed by the Contractor.
 - 3. For the purposes of these documents:
 - a. Shop Drawings are fabrication, assembly and/or installation drawings, diagrams, schedules or other documents specifically prepared for the Work by the Contractor, subcontractor, manufacturer, supplier and/or distributor to illustrate some portion of the Work.
 - b. Product Data are illustrations, standard schedules, performance charts, instructions, catalog cuts, brochures, diagrams, materials lists and other information furnished by the Contractor to illustrate materials or equipment for some portion of the Work.
 - c. Samples are physical examples which illustrate materials, equipment or workmanship and establish standards by which the Work will be judged.
 - 4. Shop Drawings, Product Data, Samples and similar submittals are not Contract Documents. The purpose of these submittals is to demonstrate for those portions of the Work for which submittals are required the way the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents.
 - 5. The Contractor shall perform no portion of the Work requiring submittal and review of Shop Drawings, Product Data, Samples or similar submittals until the respective submittal has been approved by the Engineer. Such Work shall be in accordance with approved submittals.
 - 6. The Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Engineer's approval of Shop Drawings, Product Data, Samples or similar submittals unless the Contractor has specifically informed the Engineer in writing of such deviation at the time of submittal and the Engineer has given written approval to the specific deviation. The Contractor shall not be relieved of responsibility for errors or omissions in the Shop Drawings, Product Data, Samples or similar submittals by the Engineer's approval thereof, as the Engineer's review in

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intended to cover compliance with the Contract Document and not to enter into every detail of the shop work.

7. The Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data, Samples, or similar submittals, to revisions other than those required by the Engineer on previous submittals.
8. When professional certification of performance criteria of materials systems or equipment is required by the Contract Documents, the Engineer shall be entitled to rely upon the accuracy and completeness of such calculations and certifications.

1.8 SUBMITTAL PREPARATION

- A. All drawings, information and documentation shall be prepared in English language and dimensions in US Customary units.
- B. Identify any variations or substitutions from the Contract Documents. If none exist, state "No Variations or Substitutions to the Contract Documents" in each submittal. Submit the Shop Drawing Certificate (attached) declaring and identifying any changes.
- C. When needed, clearly identify or highlighting any required field dimensions or existing elevations requests, coordination required to adjoining or related work required of the Owner or Engineer.
- D. Provide room and/or Building layout drawings to scale, identifying concrete pads, equipment placement, panel locations, piping, drains, etc. Identify dimensions to adjacent equipment or work. Identify any manufacturer's recommended space requirement for equipment access or maintenance.
- E. Identify all equipment and component dimensions, materials, special service or maintenance access requirements, wiring diagrams, motor data, etc.
- F. Provide space for Contractor and Engineer review stamps.
- G. All subcontractors and manufacturers' drawings shall first be sent directly to the Contractor, who shall keep a record of the drawing numbers and the dates of receipt. The Contractor shall:
 - a. check thoroughly all such drawings, as regards measurements, sizes of members, materials, and all other details to assure himself that they conform to the intent of the drawings and the specification,
 - b. coordinate submittal with related work supplied by others, including electrical and instrumentation equipment, and
 - c. shall promptly return to the subcontractors and/or manufacturers for correction such drawings as are found inaccurate or otherwise in error.
 - d. When properly prepared, Contractor to affix the Contractor's Review statement.

1.9 CLOUD-BASED CONSTRUCTION MANAGEMENT AND E-SUBMITTAL PROCEDURES

- A. The Contractor shall procure the services of a cloud-based construction documentation service to send/receive, store, log and otherwise manage all project submittals and documentation. Samples and color palettes shall be transmitted in a means suitable to the Owner.

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- B. The Construction Management service shall customize the project documentation folders per the Owners and Engineering's direction. The folders can include Project Meeting/Communications, Shop Drawings, O&M Manuals, Changes in the Work (RFIs, RFQs change Orders), Pay Applications, Field Observations and Photos, Materials and Other Field Tests, Start-up / Commissioning, and Construction Close-out.
- C. All submittals shall be identified in a submittals log. Submittals Types shall be identified per 1.06 A. Software shall sort on the submittal type. Contractor to provide Submittals report at each Progress Meeting.
- D. The website submittals shall be set-up to notify certain team members of posted information including shop drawings
- E. Unless otherwise noted, all transmittals, shop drawings and product data shall be in PDF, photos in .JPG and cad files in .DWG formats.

1.10 SUBMITTAL PROCEDURES

- A. Transmit each submittal with Engineer approved submittal form. Sequentially number the transmittals in accordance with the specification number. Add SD for shop drawings, OM for O&M Manuals and a brief descriptor. Re-submittals shall have original number and a sequential decimal suffix. (i.g. 15060.2 SD Pipe is the second shop drawing submittal for pipe.)
- B. Identify Project, Contractor, Subcontractor and supplier; pertinent drawing and detail number, and/or specification section number on each submittal.
- C. Apply Contractor's stamp, signed or initialed certifying that review, verification of Products required, field dimensions, adjacent construction Work, and coordination of information, is in accordance with the requirements of the Work and Contract Documents.
- D. Revise and resubmit submittals as required and identify all changes made since previous submission. Submit the full document as a re-submittal, so the last version is complete.
- E. The Engineer reserves the right to refuse to check or review any submittal of a subcontractor or manufacturer which is not presented in compliance with the foregoing requirements.

1.11 SAMPLE SUBMITTALS

- A. Submit samples to illustrate functional and aesthetic characteristics of the Product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
- B. Submit samples of sufficient size and representative of finishes indicating textures, and patterns for Owner selection.
- C. Include identification on each sample, with full Project information.
- D. Submit the number of samples specified in individual specification sections; two of which will be retained by the Engineer.

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- E. Reviewed samples which may be used in the work are indicated in individual specification sections.
- F. By approving and submitting Shop Drawings, Product Data, Samples and similar submittals, the Contractor represents that the Contractor has determined and verified materials, field measurements and field construction criteria related thereto, or contained within such submittals with the requirements of the Work and of the Contract Documents.

1.12 SUBMITTAL REVIEW

- A. The Engineer reserves the right to reject outright any submittal which is deemed incomplete or not adequately coordinated with other work elements.
- B. The Engineer will review the submittals within a reasonable time after receipt thereof and will comment directly on the PDF submittal with any notes or corrections which may be necessary to meet the Contract requirements.
- C. The Contractor shall then review such notations and/or instructions and if he concurs therein, shall make or have made such required corrections, and shall repost corrected drawings to the website for final review. The Contractor shall include a 'cover sheet' identifying how each comment was addressed. The entire submittal shall be resubmitted such that the final accepted submittal is complete.
- D. Such further review by the Engineer will be limited to the corrections only, and the Contractor, by such re-submission shall be held to have represented that such drawings contain no other alterations, additions or deletions, unless the Contractor (in writing) directs the Engineer's specific attention to same. Should the Contractor question, or dissent from, such notations and/or instructions, he shall so inform the Engineer and request further clarification before resubmitting the drawings.
- E. The review of Contractor's, subcontractors', and manufacturers' drawings by the Engineer is for coordination and assistance, and the Engineer does not thereby assume responsibility for errors or omissions. Such errors or omissions must be made good by the Contractor, irrespective of the receipt, review of the drawings by the Engineer, and even though the work is done in accordance with such drawings.
- F. Manufacturer Certificates
 1. When specified in individual sections, submit manufacturer's certification to the Engineer.
 2. Indicate material or Product meets or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
 3. Certificates may be recent or previous test results on material or Product, but must be acceptable to the Engineer.

1.13 SHUT-DOWN SCHEDULE AND WORK PLANS

- A. The Contractor shall schedule shut-downs a minimum of 10 days in advance. Such shut-downs can include bulkhead installation and removal, pump, valve or pipe replacement, hydraulic connections and electrical and instrumentation connections.

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- B. The Contractor shall submit a Shut-Down Work Plan for each interruption, on a form provided by the Engineer.

1.14 EQUIPMENT INSTALLATION, CALIBRATION REPORT AND SERVICE REPORT

- A. When specified, the Manufacturer shall submit a certificate to check that the equipment has been properly installed by the Contractor and calibrated or set-up by the field technician.
- B. When a product or equipment must be checked or serviced, a service report shall be submitted identifying what was served or if any parts were replaced.
- C. Additional demonstration submittals are detailed in Section 01650.

1.15 START-UP AND COMMISSIONING DOCUMENTS

- A. Submit documents in accordance with Section 01650.

1.16 CONTRACT CLOSE-OUT DOCUMENTS

- A. Submit Contract Close-out Documents per Section 01700.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

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SECTION 01310

CONSTRUCTION SCHEDULES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Project Construction Schedule and look-ahead schedules
- B. Format, content, revisions and submittals

1.2 RELATED SECTIONS

- A. Section 01300 - Submittals: Shop drawings, product data, and samples
- B. Section 01950, 3.15 Substantial Completion

1.3 QUALITY ASSURANCE

- A. Any and all float shall not be used exclusively by Contractor but shall be available to both the Owner and Contractor alike.
- B. Any schedule showing completion of the Work prior to the contractual Substantial and/or Final Completion dates, nor the review of such schedule shall signify agreement and acceptance of early completion, nor shall it be a means on which to base delay claims.
- C. The Contractor shall obtain input from all sub contractors when compiling and updating the schedules.
- D. The schedule shall be prepared using Primavera, Microsoft Project or approved software.

1.4 CONSTRUCTION SCHEDULE FORMAT

- A. Identify each work element with a task ID.
- B. Prepare schedule as a horizontal bar chart with separate bar for each major portion of work or operation, identifying first workday of each week.
- C. Sequence of Listings: The chronological order of the start of each item of work.
- D. Show link to interdependent tasks as a dashed or phantom line
- E. Critical path: Denote Work in red.
- F. Scale and Spacing: To provide space for notations and revisions.
- G. Sheet Size: 11 x 17 inches

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1.5 CONSTRUCTION SCHEDULE CONTENT

- A. Identify Notice to Proceed, intermediate Substantial Completion (See Section 01950, 3.15), Project Substantial Completion and Final Completion dates.
- B. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.
- C. Identify the dates and duration when processes or major equipment are taken out of service.
- D. The schedule will include submittal preparation, review, re-submittal, fabrication/assembly, delivery, installation, testing and startup for all major equipment.
- E. Include equipment start-up and facility commissioning
- F. Identify the Project Float, defined as the time between early completion and final (contractual) completion.
- G. Identify interdependent work elements.
- H. Identify work per 01950, 3.15 and other logical / grouped activities.
- I. Provide sub-schedules to define critical portions of the entire schedule.
- J. Show accumulated percentage of completion of each item, and total percentage of Work completed, as of the last day of each month.

1.6 REVISIONS TO CONSTRUCTION SCHEDULES

- A. The construction schedule shall be updated for each progress meeting, but not more often than twice a month.
- B. Indicate progress of each activity to date of submittal, and projected completion date of each activity.
- C. Identify activities modified since previous submittal, including any schedule slippage, revision to Project Float, major changes in scope, and other identifiable changes.
- D. Provide narrative report to define problem areas, anticipated delays, and impact on Schedule. Report corrective action taken, or proposed, and its effect, on schedules of separate contractors

1.7 SUBMITTALS

- A. Submit initial schedule within 30 days of the NTP.
- B. Submit initial and all revisions to the submittals website
- C. Bring color paper copies to Progress Meeting when requested.

1.8 LOOK-AHEAD SCHEDULES

- A. Look-Ahead Schedules are informal short-term schedules used to present the work details in a two-week or an otherwise agreed upon period, to help facilitate construction coordination.
- B. Look-ahead schedule will include shutdowns, inspections, start-up, and other key dates, equipment deliveries and critical path submittals. They do not include float, critical path work, interdependencies, or other details show on the construction schedule.
- C. Present Look-ahead schedules to the RPR each week as a means of coordinating work activities and at each Progress Meeting.
- D. Look-ahead schedule format can be excel, word or other informal means

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

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SECTION 01400

QUALITY CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Quality assurance – Quality Control of installation, tolerances, references, mockup, inspecting and testing laboratory services, and manufacturers' field services and reports.
- B. Quality Control (QC) Plan, to ensure an acceptable level of quality for all products, materials, equipment, and the proper coordination, installation and start-up of the same.

1.2 RELATED SECTIONS

- A. Section 01300 - Submittals: Submission of manufacturers' instructions and certificates.
- B. Section 01600 – Materials, Products and Equipment: Requirements for material and product quality.

1.3 SUBMITTALS

- A. Corporate Quality program, including training, certificates, or other personnel advancements.
- B. Quality Control Plan for this project, including procedures to:
 - 1. Review and coordinate submittals prior to posting
 - 2. Field verify key measurements
 - 3. Monitor the quality of subcontractor's work
 - 4. Scheduling, coordinating and monitoring all on-site testing
 - 5. Means to identify, track and remedy non-satisfactory work
- C. Submittals shall be reviewed, signed and posted by the QC Officer.

1.4 QUALITY ASSURANCE – QUALITY CONTROL OF INSTALLATION

- A. The Contractor shall maintain quality through construction, including the monitoring quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Contractor to name a Quality Control Officer, responsible for all aspects of QC. The QC Officer shall be an on-site engineer with at least 20 years of related experience.
- C. Contractor shall contract with subcontractors with specific expertise in the contracted areas of work. Subcontractors field personnel shall have expertise, training and certifications in the specific areas of their work. Master millwrights, plumbers, electricians are required for key installations.
- D. The installation contractor(s) shall comply with manufacturers' instructions in each step of the installation sequence, including the use of any specific tools.

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- E. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.
- F. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- G. Perform work by persons qualified to produce workmanship of specified quality.
- H. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.5 TOLERANCES

- A. Pipe, tubing, conduit, supports, etc. shall be plumb vertically and horizontally. Unless identified elsewhere, out of plumb shall be no more than 1/4" in 10 feet. Where multiple runs are installed, each pipe, tube, conduit shall be directly in-line and equally spacing to the other pipes, tubes or conduits.
- B. Contractor to monitor tolerance control of installed products to produce uniform quality Work. Where non-uniform or out-of-plumb work is identified, work shall be corrected to the tolerance specified or the Owner's approval.
- C. Where specifications are available, comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.
- D. Adjust Products to appropriate dimensions; position before securing Products in place.

1.6 REFERENCES

- A. For Products or workmanship specified by association, trade, or other consensus standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard by date of issue current on date specified in the individual specification sections, except where a specific date is established by code.
- C. Obtain copies of standards where required by product specification sections.
- D. The contractual relationship, duties, and responsibilities of the parties in Contract nor those of the Architect/Engineer shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.7 MOCK-UP

- A. Tests will be performed under provisions identified in this section and identified in the respective product specification sections.

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- B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
- C. Accepted mock-ups are representative of the quality required for the Work.
- D. Where mock-up has been accepted by Architect/Engineer and is specified in product specification sections to be removed; remove mock-up and clear area when directed to do so.

1.8 TESTING SERVICES

- A. The Contractor to hire and provide independent third-party testing services as necessary to comply with the specification herein. Testing shall include:
 - 1. Soil material Compaction tests
 - 2. Concrete material air, slump and compression tests
 - 3. Pachometer or GPR tests (01045, 3.1 C.)
 - 4. Anchor pull-out tests
 - 5. H&V balance tests
 - 6. Electrical tests
 - 7. Non-destructive examination tests for bolting and welding.
 - 8. Discontinuity (holiday) testing of concrete protective coating systems.
 - 9. Other tests as identified herein.Note: Pressure tests can be performed by the Contractor, and equipment start-up tests are identified elsewhere
- B. The independent firm's qualifications shall be submitted for approved by the Engineer. The testing firm will perform inspections, tests, and other services specified in individual specification sections and as required by the Engineer or the Owner.
- C. Inspecting, testing, and source quality control may occur on or off the project site. Perform off-site inspecting or testing as required by the Engineer or the Owner.
- D. Reports will be submitted by the independent firm to the Engineer, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.
- E. Contractor to cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
 - 1. Notify Engineer and independent firm 48 hours prior to expected time for testing services.
 - 2. Make arrangements with independent firm and pay for additional samples and tests required for Contractor's use.
- F. Testing or inspecting does not relieve Contractor of performing Work to contract requirements.
- G. Retesting required because of non-conformance to specified requirements shall be performed by the same independent firm on instructions by the Engineer.

1.9 MANUFACTURERS' FIELD SERVICES AND REPORTS

- A. When specified in individual specification sections, require material or Product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of

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surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment and as applicable, and to initiate instructions when necessary.

- B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.
- C. Submit report in duplicate within 30 days of observation to Engineer for information.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

- A. The QC Officer shall:
 - 1. Review all product data for application requirements
 - 2. Monitor paint surface preparation and coat mil thickness
 - 3. Observe and access aesthetics of masonry, tile and grout work
 - 4. Monitor ambient and substrate temperatures and production application temperature requirements
 - 5. Monitor bolt and anchor torque
 - 6. Coordinate the same with the on-site RPR.
- B. The QC Officer shall review all work and perform a preliminary punch-list inspection for all items that do not conform to the construction documents.
- C. Perform at critical junctures in the work and prior to intermediate Substantial Completion items. Provide that list as a QC Report to the Engineer.
- D. Monitor correction of any deficiencies. When corrected, notify the Engineer that the facility or area is ready for the Engineer's inspection.
- E. QC Officer may be requested to attend the final inspection along with the Engineer and Owner.

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SECTION 01500

UTILITIES AND TEMPORARY FACILITIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Temporary Utilities: Electricity, lighting, heat, ventilation, water supply, and sanitary facilities.
- B. Temporary Controls: Fire Protection, Barriers, enclosures and fencing, protection of the Work, and ground and surface water control.
- C. Construction Facilities: First Aid Facilities Access roads, parking, progress cleaning, project signage, existing utilities, structures and temporary buildings.

1.2 RELATED SECTIONS

- A. Section 000_ITB – Instructions to Bidders
- B. Section 01005 - Administrative Provisions
- C. Section 01580 - Project Signs.
- D. Section 01700 - Contract Closeout: Final cleaning.

1.3 TEMPORARY ELECTRICITY AND LIGHTING

- A. Owner to provide and pay for the reasonable use of electrical utilities.
- B. The Contractor shall provide all necessary panels, disconnects, conduit, cables and equipment required for safe, temporary service. All circuits shall be insulated, weatherproof, equipped with an equipment grounding conductor. All enclosures and devices shall be weatherproof.
- C. Provide adequate distribution equipment, wiring, and outlets to provide single phase branch circuits for power and lighting.
- D. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required.
- E. Maintain temporary lighting throughout the site and provide routine repairs.

1.4 TEMPORARY HEAT AND VENTILATION

- A. The Contractor shall provide heat and ventilation as required to maintain specified conditions for construction operations and to protect materials and finishes from damage due to temperature or humidity. Temporary heat and ventilation is required during mechanical H&V

installation when ventilation may not meet NFPA 820 requirements or if temperatures are below normal working conditions.

- B. The Contractor shall provide ventilation of enclosed areas to ensure safe atmospheres for Construction, Owner, and Engineer's staff, as well as to cure materials; to disperse humidity; and to prevent accumulations of dust, fumes, vapors, or gases.
- C. Prior to operation of permanent equipment for temporary heating purposes, verify that installation is approved for operation, equipment is lubricated and filters are in place. Provide and pay for operation, maintenance, and regular replacement of filters and worn or consumed parts until Substantial Completion.

1.5 TEMPORARY WATER SERVICE

- A. Process Effluent Water (PEW) is available for the Contractor's use in any quantity.
- B. Potable water must be purchased and metered. Any temporary extension of the facilities shall be installed by the Contractor and removed at the completion of his work. The construction of the temporary facilities shall meet all state and local codes and shall include a meter with totalizer.
- C. If potable water connections are made to the hydrants, the Contractor shall obtain authorization from the appropriate Fire Department. The Fire Department standard wrench shall be used for opening and closing the fire hydrants. Fire hydrants shall be pumped out and left dry after each use regardless of the season of the year.

1.6 TEMPORARY SANITARY FACILITIES

- A. Provide and maintain adequate and required facilities and enclosures during the entire duration of the project.
- B. The use of Owner's facilities is prohibited.

1.7 TEMPORARY FIRE PROTECTION

- A. The Contractor shall follow the standards of the National Fire Protection Association during torch cutting or welding on the job site.
- B. The Contractor shall provide a suitable number of portable fire extinguishers (non-freeze type in cold weather) distributed about the job site.
- C. The Contractor shall store gasoline and other flammable liquids in U.L. listed safety containers in a location away from the building and distribute the liquids directly from the containers. Storage of flammable liquids shall not be allowed inside of any municipal or county building or structure.

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1.8 TEMPORARY BARRIERS

- A. The Contractor shall provide barricades, and adequate warning flags, signs, and lights in accordance with governing laws and ordinances to protect construction areas, existing facilities, and adjacent properties.
- B. Provide barricades and covered walkways required by governing authorities for public right-of-way and for public access to existing building.
- C. Provide protection for plant life designated to remain. Replace damaged plant life.
- D. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.9 TEMPORARY ENCLOSURES

- A. The Contractor shall provide a construction plan layout showing the arrangement of temporary buildings, construction equipment, and storage and work areas. The plan must be approved by the Engineer prior to erection.
- B. The Contractor shall provide temporary insulated weather tight closure of all exterior openings to accommodate acceptable working conditions and protection for Products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks. All access openings shall be approved by the Engineer.
- C. Provide temporary partitions and ceilings as indicated to separate work areas from Owner occupied areas, to prevent penetration of dust and moisture into Owner occupied areas, and to prevent damage to existing materials and equipment.
- D. Provide temporary protection of electrical gear to prevent dust intrusion from construction operations. Protection shall not overheat existing gear. (Engineer to review and approve protection measures.)
- E. Repair any anchor penetrations following removal.

1.10 TEMPORARY ACCESS ROADS

- A. Construct and maintain temporary roads accessing public thoroughfares to serve construction area.
- B. Extend and relocate as Work progress requires. Provide detours necessary for unimpeded traffic flow.
- C. Provide and maintain access to fire hydrants, free of obstructions.
- D. Provide means of removing mud from vehicle wheels before entering streets.

1.11 TEMPORARY PARKING

- A. When necessary, provide temporary gravel surface parking areas to accommodate construction personnel. Return the area to pre-construction conditions or as identified herein or on the drawings.
- B. When site space is not adequate, provide additional off-site parking.
- C. Do not allow vehicle parking on existing pavement that may restrict WWTP traffic flow.
- D. When necessary, designate two parking spaces for the Owner and RPR.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

- A. Remove temporary utilities, equipment, facilities, materials, prior to Substantial Completion inspection.
- B. Completely remove underground installations where shown on the drawings. Abandon in place only where shown. Compact soil per Division 02 and grade site as indicated or to existing conditions.
- C. Clean and repair damage caused by installation or use of temporary work.
- D. Restore existing and permanent facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

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SECTION 01600

MATERIALS, PRODUCTS AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY OF WORK

- A. This Work includes:
 - 1. Transportation, storage, handling, and installation of all work.
 - 2. Maintenance of stored and installed equipment.
 - 3. Product options and substitutions for materials and equipment supplied and installed.
 - 4. The type of materials required relative to their environment.

1.2 RELATED SECTIONS

- A. Section 01300 - Submittals.
- B. Section 01400 - Quality Control

1.3 SUBMITTALS

- A. Maintenance Log, updated monthly

1.4 GENERAL PROVISIONS

- A. Materials, Products and Equipment (MP&E) (including all materials, machinery, equipment, components, hardware, anchors, couplings, and ancillary equipment or systems) shall be carefully designed, manufactured and installed to ensure that all required functions are adequately performed within specified degrees of precision, performance criteria are met, and that each unit shall operate with every other part, furnished or existing, to provide a complete integrated system which shall operate to the satisfaction of the Engineer.
- B. The Contractor shall recognize and acknowledge that the Contract Documents may represent a specific product make and model even though other makes and models may be specified or accepted as substitutes. Any changes or revisions of work made necessary by the type and dimensions of furnished MP&E shall be made at no cost to the Owner, and he shall furnish detail drawings showing such changes or revisions for the approval of the Engineer.
- C. All materials, equipment, and accessories shall be new and unused and shall be essentially the products of a manufacturer regularly engaged in the production of such material or equipment and shall essentially duplicate material or equipment that has been in satisfactory operation at least 5 years.
- D. The owner reserves the right to reject any material or equipment manufacturer who, although he meets the above requirements, does not provide satisfactory evidence indicating adequate and prompt post-installation repair and maintenance service as required to suit the operational requirements of Owner.

- E. Items of any one type of materials or equipment shall be the product of a single manufacturer.

1.5 TRANSPORTATION AND HANDLING

- A. No equipment, materials or other products shall be shipped without O&M Manuals, or approved storage, handling and/or maintenance requirements from the manufacturer.
- B. The manufacturer shall crate all parts of equipment carefully to facilitate shipping and handling. Crates shall completely protect the equipment and be sufficiently strong to permit lifting and skidding without additional bracing or reinforcement.
- C. Transport and handle MP&E in accordance with manufacturer's instructions. Transport and handle all MP&E in such a manner to avoid breakage, inclusion of foreign materials, and/or damage by water or other causes.
- D. All equipment shipments shall be identified on the Maintenance Log. Notify the Engineer at least two days in advance of the delivery of equipment. The Engineer or RPR shall be notified of the time of delivery and shall be present. The Contractor shall inspect all equipment before off-loading.
- E. Equipment cannot be shipped or accepted at the site prior to 2 weeks before installation. Equipment shall not be delivered unless it can be immediately incorporated into the work or proper storage facilities are available.
- F. Deliver packaged materials in original unopened shipping containers. Packages or materials showing evidence of damage or contamination regardless of cause will be rejected. The Contractor shall promptly inspect apparently undamaged shipments to ensure that MP&E comply with requirements, quantities are correct, and MP&E are undamaged.
- G. The Contractor shall repair or replace all items damaged or broken as a result of the Contractor's operation at no cost to the Owner.
- H. When specified in individual sections, equipment shall be tested or made available for performance witness testing by the Engineer at the factory prior to shipment.
- I. Provide equipment and personnel to handle, off-load and store MP&E to prevent damage.

1.6 STORAGE AND PROTECTION

- A. When MP&E cannot be immediately incorporated into the Work, store, protect and maintain MP&E in accordance with manufacturers' instructions.
- B. Store sensitive MP&E in weather tight, climate controlled enclosures. Provide bonded off-site storage and protection when site does not permit on-site storage or protection.
- C. For exterior storage of MP&E, place on sloped supports, above ground. Cover all openings.
- D. Cover MP&E subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation or potential degradation of Product. Provide temporary heat where required.

- E. Provide power to all motor heaters if stored outdoors or in unheated areas. Rotate all shafts periodically as required by the manufacturer.
- F. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
- G. Arrange storage of MP&E to permit access for inspection and maintenance. Periodically inspect to verify MP&E are undamaged and are maintained in acceptable condition.

1.7 MAINTENANCE OF STORED AND INSTALLED EQUIPMENT

- A. The Contractor shall remain responsible for the care and proper maintenance of all stored and installed equipment until the Work is accepted per Section 01650 and defined as Substantially Complete.
- B. The Contractor shall submit a Maintenance Log 10 days prior to the first delivery and shall update and resubmit the Log prior to accepting delivery of all new equipment. Notify the Engineer at least two days in advance of the delivery of equipment. The log shall:
 - 1. Identify when the shipments are scheduled to arrive.
 - 2. Identify the manufacturer's requirements including the time and/or frequency of the required maintenance. Note: This must be provided by the Mfr.
 - 3. Identify the date, time and initials for recording when the maintenance is performed.
- C. No equipment, materials, or other MP&E shall be shipped without approved O&M Manuals, or approved storage, handling and/or maintenance requirements from the manufacturer.
- D. The Contractor shall rotate, lubricate, heat, and otherwise maintain all equipment in accordance with the Maintenance Log until acceptance by Owner. The Contractor shall record in the log, the maintenance performed and by whom, immediately after performance.
- E. The Engineer shall review the log from time to time and may reject partial payment if the maintenance is not being performed as required. The Engineer may also, from time to time, inspect the maintenance being performed.
- F. The log shall be turned over to the Owner prior to Substantial Completion. The Owner will maintain equipment following Substantial Completion.

1.8 PRODUCT OPTIONS

- A. Products specified by Reference Standards or by Description Only:
 - 1. Any Product meeting those standards or description may be submitted for review.
- B. Products specified by naming one or more manufacturers with a provision for "or Equal" or "Approved Equal":
 - 1. Substitutions are allowed
 - 2. Submit a request for substitution for any manufacturer not named in accordance with the following article.
 - 3. Refer to ITB document for requirements on substitution requests.

- C. Products specified by naming one or more manufacturers with the provision "No Substitutions":
 - 1. Provide products of named manufacturers meeting specifications,
 - 2. No substitutions are allowed.

1.9 "OR EQUAL" CLAUSE

- A. Specifying an article, material, or piece of equipment by reference to a proprietary product or by using the name of a manufacturer or vendor followed by the clause "or equal" shall be understood to indicate the type, function, minimum standard of design, efficiency, and quality required and shall not be construed in such a manner as to exclude MP&E of comparable quality, design, and efficiency.
- B. Comparable MP&E shall be capable of performing equal function and shall be compatible with other equipment, materials, or systems to which they connect or will become an integral part of.
- C. The clause "or approved equal" which may appear elsewhere in the documents shall mean the same as "or equal".
- D. Wherever a MP&E is defined by specifying a proprietary product or manufacturer, the term "or equal" is not be implied.
- E. Substitutions of "or equal" MP&E are subject to the approval of the Engineer.

1.10 SUBSTITUTIONS

- A. Engineer will only consider Requests for Substitutions following the Bid, provided those substitutions are listed in the ITB Bid Form, Section 2. There is no guaranty that any listed substitution will be approved.
- B. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.
- C. Each request shall include the credit amount for the substitution. This amount must include any and all cost adjustments to the other trades as a result of this substitution.
- D. A request constitutes a representation that the Contractor:
 - 1. Has investigated proposed Product and determined that it meets or exceeds the quality level of the specified Product.
 - 2. Will provide the same warranty for the Substitution as for the specified Product.
 - 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
 - 4. Waives claims for additional costs or time extension which may subsequently become apparent.
- E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

- F. Substitution Submittal Procedure:
1. Formally submit or post the Request For Substitution (RFS) for consideration. Limit each request to one proposed Substitution.
 2. Contractor shall submit for each proposed substitution sufficient details, complete descriptive literature and performance data together with samples of the materials where feasible to enable the Engineer to determine if the proposed substitution is equal to that specified.
 3. Contractor shall submit certified tests where applicable by an independent laboratory, acceptable to the Owner, attesting that the proposed substitution is equal.
 4. A list of installations where the proposed substitution is used.
 5. Requests for substitutions shall include full information concerning differences in cost, and any savings in cost resulting from such substitutions shall be passed on to the Owner.
 6. The Engineer will prepare a Work Change Directive, which will include the hours and cost to review the substitution request. A decision will then be made by the Owner, in review of the credit amount, and savings in O&M costs and the cost to review the substitution.
 7. Where the approval of a substitution requires revision or redesign of any part of the work, all such revision and redesign and all new drawings and details required, therefore, shall be provided by the Contractor at his own cost and expense and shall be subject to the approval of the Engineer.
 8. In all cases, the Engineer shall be sole judge as to whether a proposed substitution is to be approved. The Contractor shall abide by the Engineer's decision when proposed substitute items are judged to be unacceptable and shall in such instances furnish the item specified or indicated. No substitute items shall be used in the work without approval of the Engineer.

PART 2 - PRODUCTS

2.1 ATMOSPHERIC AND NFPA 82 DESIGNATIONS

- A. Atmospheres to establish the minimum material characteristics are designated as Chemically Corrosive, Heavily Corrosive, Moderately Corrosive and Neutral. Area designations relative to these atmospheres are shown on Sheet G-02
- B. Atmospheres for fire protection shall following NFPA 820 Standards for Fire Protection in Wastewater Treatment and Collection Facilities, 2008 edition. Area designations relative to NFPA 820 are show on Sheet G-02

2.2 MATERIALS

- A. Unless otherwise specified, materials for miscellaneous metals, anchors, hangers and supports, Unistrut, pipe/wall sleeves, hardware (nuts, bolts, washers), segmented compressible seals (rubber and hardware), shims/spacers/plates, etc., incorporated into the work are designated in accordance with the atmosphere, location and/or condition of service.
- B. The materials shall apply to all trades and subcontractors

- C. Table 1 identifies the minimum material type or products to be used for each atmospheric designation. Where more stringent materials are identified on the Drawings or Details Specifications, those materials shall be used.

TABLE 1: ATMOSPHERES, AREAS AND MATERIALS

Area Designation	Process/Building Areas	Materials
Chemically Corrosive (CC)	N/A	PVC, FRP, 316 SS and Titanium. Material selection must be compatible with the product.
Heavily Corrosive (HC)	Headworks Building, including the screenings room, and garage / storage area, South Headworks Building and South Garage Outside areas including Raw Influent Pump Station, Upper and Lower Alcove Area, Influent Flow Area, Within 18" Above Exterior Grit Chambers and Channels, and Flow Splitter Area	316 (L) SS.
Moderately Corrosive (MC)	Odor Control + Grit Pump Building, Outside Odor Control Vessels, Larger than 18" Above Tank Deck	Galvanized carbon steel.
Neutral (N)	Headworks Building Electrical Room	Painted/coated carbon steel (See Specification 09900)

- D. **STAINLESS STEEL**
1. Provide 316 in all areas except wet wells and inside of tanks.
 2. 304L and 316 L – Low Carbon stainless steel – shall be used for all welding applications. 304/316 shall be used for all other applications.
 3. Stainless steel shall meet ASTM A240, A312, A403, A774, A778, and must be pickled. 316 (L) shall be used for all applications visible without combined space entry.
 4. Stainless steel shall not be used directly with chlorine related compounds; titanium must be used instead.
- E. **Galvanized Steel**
1. Galvanizing is specified in Section 05500.
- F. **PVC and FRP**
1. PVC and FRP materials, seals and gaskets must be appropriate for the chemical/application.
- G. Where different atmospheric conditions apply to the same material, the harsher environment controls the material type, e.g., a sleeve through a pipe gallery into a tank must be 316 SS.

- H. Architectural and structural product materials may be specified elsewhere and take precedence over this specification.

2.3 NEMA RATINGS AND ELECTRICAL CONDUIT AND COMPONENTS

- A. Provide NEMA rated panels and conduit materials as show on G-02.
- B. Electrical components relative to NFPA atmospheric conditions, including intrinsically safe components for Class 1, Divisions 1 and 2 environments, are specified in Division 16.

PART 3 - EXECUTION

- 3.1 Contractor shall coordinate all materials with Subcontractors, Suppliers and Vendors at the time of the Bid.

END OF SECTION

SECTION 01650

EQUIPMENT START-UP, DEMONSTRATION AND FACILITY COMMISSIONING

PART 1 PART 1 - GENERAL

1.1 SUMMARY OF WORK

- A. This section includes all work necessary to start-up and accept equipment and commission facilities to achieve Substantial Completion.
- B. Contractor shall perform Equipment Start-up, Equipment Demonstration and Facility Commissioning in a planned, logical and organized manner.
- C. All I/O, discrete or analog shall be field verified, including all manual and automatic controls, warnings, alarms, sequences, status, etc. Field verification will be demonstrated locally and remotely, as well as SCADA controlled operation.
- D. Manufacturer's Equipment Start-up includes:
 - 1. Anchoring, tightening, adjusting, alignment, etc.
 - 1. Calibration
 - 2. Limit or level settings
 - 3. Rotation, amp draw, voltage (phase-to-phase)
 - 4. Completion of Manufacturer's pre-demonstration check list
 - 5. Submit check list, field report and Certificate of Proper Installation (form provided by the Engineer)
- E. Equipment Demonstration includes:
 - 1. Approval of Demonstration Work Plan, including
 - a. List of all I/O, discrete and analog
 - b. Functionality Checklist
 - c. Performance Data Sheet
 - 2. Witness functionality and performance tests including all automatic controls and SCADA functionality by Owner or Engineer
 - 3. Record and submit Baseline Operating Data
- F. Facility Commissioning includes the following
 - 1. Successful demonstration and acceptance of all equipment/components.
 - 2. Factory and Site Acceptance Tests (FATs and SATs) of all equipment operating collectively
 - 3. System Training
- G. Substantial Completion includes the following:
 - 1. Proper off-loading, storage and maintenance of equipment
 - 2. Approval of all submittals
 - 3. Successful Equipment Start-up and submittals
 - 4. Successful Equipment Demonstration and submittal of base-line operating data
 - 5. Training
 - 6. Turning over Spare Parts and Special Tools

- 7. O&M Manual
- 8. Project documentation

H. The cost of all work herein shall be included as part of the Work.

1.2 RELATED REQUIREMENTS

- A. Section 01300 – Submittals
- B. Section 01310 – Construction Schedules
- C. Section 01600 – Materials and Equipment
- D. Section 01700 – Contract Closeout
- E. Section 01730 – O&M Data
- F. Section 01950 – Sequence of Construction & Special Project Requirements
- G. Section 16980 – Demonstration and Testing

1.3 SUBMITTALS

- A. Equipment Start-up Work Plans (Form provide by Engineer)
- B. Equipment Demonstration Work Plan (Form provide by Engineer)
- C. Updated Maintenance Log (Form provide by Engineer)
- D. Certificate of Proper Installation and Start-up (Form provide by Engineer)
- E. Equipment Start-up Report
- F. Baseline operating data
- G. Laser Alignment Report (when required)
- H. Certificate of Proper Equipment Site Acceptance Tests (Form provide by Engineer)
- I. Training package
- J. Signed Training Roster sheet following training.
- K. Revisions to O&M Manual (where required) following training.
- L. Spare Parts list for all parts and consumables specified for the Work.
- M. Video recordings of training sessions

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1.4 QUALITY ASSURANCE

- A. A highly qualified Start-up Technician is required to verify proper installations, perform pre-demonstration activities, place the equipment in operation, demonstrate full functionality and train Owner personnel in all O&M procedures. The Start-up Technician shall have at least 10 years related equipment experience, and 5 years specific startup experience with the make and model of the installed equipment.
- B. Training materials and instructions shall be prepared and provided by the same Technician. Training materials and instructions shall be specific to the equipment and/or system installed under this Contract.

1.5 SCHEDULING

- A. Identify Equipment Start-up, Demonstration Facility Commissioning and training in the Construction Schedule. Adjust as the time approaches and include on Look-Ahead Schedules.
- B. The Engineer and Owner shall be notified ten working days in advance of Demonstration, Commissioning and Training.
- C. Classroom and field training programs shall be conducted after satisfactory completion of Demonstration and prior to Substantial Completion.

1.6 MANUFACTURER'S EQUIPMENT START-UP

- A. The purposes of these activities are to assure that the equipment is properly installed, functions properly and is capable of executing all the necessary operations and performance during Equipment Demonstration
- B. Manufacturer's Equipment Start-up is generally not witnessed by the Owner / Engineer.
- C. The Start-up Technician shall verify:
 - 1. That the equipment shipped and installed is the same as the equipment approved
 - 2. Proper installation which can include:
 - a. Connections and pump nozzle strain
 - b. Leveling, alignment and alignment report
 - c. Anchors, supports and grout,
 - d. Grease and lubrication
 - e. warning / alarm calibration and settings
 - f. rotation, voltage, grounding, etc.
- D. Contractor shall notify the Engineer when any activities required to setup or calibrate newly installed equipment are outside the Contractor's direct control.
- E. Where additional third-party tests are required (i.e., vibration, grounding, megger, etc.) the tests shall be performed at this time by approved specialists hired by the Contractor. [Note these test does not need to be repeated during Equipment Demonstration, provided the report is submitted and data are satisfactory.] If data are out of the specified tolerance, the Contractor shall realign/re-install or otherwise correct ths flows and repeat the tests prior to Equipment Demonstration.

- F. Once complete, submit a *Certification of Proper Installation*, Equipment Start-up Field Report, baseline operating conditions and laser alignment report for rotating equipment.

1.7 EQUIPMENT DEMONSTRATION WORK PLAN

- A. The Contractor shall submit an Equipment Demonstration Form 10 working days prior to equipment startup. (The Engineer will provide the form.)
- B. The Equipment Demonstration Plan shall list the tests necessary to verify that the equipment and any ancillary or system components are fully functional and meets any specified performance standards. Such tests and/or data collection shall include but may not be limited to the following:
 - 1. Local Functionality
 - a. On/Off, Open/Close, Reversing, etc.
 - b. Local lights.
 - c. Speed/Position Indication/Control.
 - 2. Local Interlocks and Alarms Functionality
 - a. E-stop buttons, cables, and other safety devices.
 - b. High/low position, pressure, temperature, etc.
 - 3. Remote Control and SCADA Indication Functionality
 - a. Full automatic operation
 - b. Verification of operation, performance, alarms, etc., on remote panel and SCADA terminal.
 - c. All I/O shall be listed and verified.
 - 4. Performance data, such as:
 - a. Flow, pressure, and/or through-put at duty point condition
 - b. Similar performance at alternate speeds, positions, etc.
 - c. Vibration, temperature and/or noise levels
 - d. Electrical performance such as amp draw, voltage, ground resistance and power factor, or efficiencies.
 - e. Cycle tests, internal calibration or diagnostics check.
 - f. Any other tests necessary to verify compliance with the specifications
- C. Functionality Checklist
 - 1. Submit list of equipment I/O, discrete and analog
 - 2. Complete Functionality Checklist
- D. Performance Data Form
 - 1. Coordinate with Engineer on Performance Data Form to be used during Demonstration
 - 2. The form shall also include but is not limited to:
 - a. Time of startup and completion of tests
 - b. Participants
 - c. Weather, temperature data
 - d. Major test apparatus information
- E. The Contractor shall verify in the Equipment Demonstration Form that all required submittals have been submitted and approved.

- F. The Contractor shall confirm that tests for any ancillary equipment are complete and accepted prior to demonstration. Tests for ancillary equipment can include flow meter calibration, level device calibration, pressure tests for pipe, leak tests for storage tanks, compressed air system, water supply bacterial tests, MCCs and electrical gear tests such as megger and ground, etc.

1.8 EQUIPMENT DEMONSTRATION

- A. Equipment Demonstration will begin following receipt of Manufacturer's Start-up report and certification.
- B. The Start-up Technician shall conduct a preliminary meeting to discuss the demonstration tests, identifying data to be recorded and by whom, the role of any other technicians for ancillary equipment or confirmation of remote SCADA functionality, and a discussion of field calibration performed prior to the start-up tests.
- C. The Contractor and/or Start-up Technician shall perform in the presence of the Engineer, those performance and/or functionality tests identified in the Demonstration Work Plan or any other tests required to verify system/equipment performance.
- D. All data taken during Equipment Demonstration shall be verified by the Engineer and recorded by the Start-Up Technician on the Functionality Checklist and Performance Data form.
- E. When testing is complete, the forms shall be initialed by the Engineer and signed by the Start-up Technician and copies provided to the Owner and Engineer before the Technician leaves the site.
- F. Contractor shall be available to promptly repair or replace all defective and/or damaged work or equipment during the start-up period so as to minimize disruption to the total facility operation.
- G. In the event a system, equipment, or component proves defective or is unable to meet the specified performance criteria, the Contractor shall replace the defective item and the demonstration will restart.
- H. Following successful completion of Equipment Demonstration, the equipment shall run successfully in full automatic mode for a period of 30 days for final acceptance.

1.9 FACILITY COMMISSIONING

- A. When the Work requires that multiple pieces of equipment operate in unison or collectively in a process area or facility, Facility Commissioning is required. The Contractor shall submit a Facility Commissioning Work Plan 10 working days prior to startup (The Engineer will provide the Facility Commissioning form).
- B. Equipment demonstrations must occur prior to Facility Commissioning.
- C. The Facility Commissioning Work Plan shall list the tests necessary to verify that the Facility is fully functional and meets the full intent of the plans and specifications. Facility Commissioning shall demonstrate that all equipment in the facility are functioning alternately, collectively and/or in unison, processing the water, wastewater or solids as intended including

alarms, interlocks, automatic control, sequencing, shut down, etc. Such tests shall include but may not be limited to the following:

1. All modes of remote equipment operation including SCADA and automatic.
 2. I/O, alarms and interlocks to a main control panel and remote SCADA terminals.
 3. Startup and shutdown sequences.
 4. System Interlocks.
 5. Safety provisions (such as pressure relief, chemical exposure, etc.).
 6. Any other tests necessary to verify compliance with the specifications.
- D. Wherever possible, a dry-run or off-line operation shall be employed prior to putting the facility on-line. A dry-run is considered to be the use of generated signals (such as 4-20mA level, pressure, flow, etc.) to determine proper operation. Off-line operation is when SFE or alternate flows are used in lieu of the actual wastewater or sludge flow.
- E. A dry-run plan shall be developed and implemented jointly between the Engineer and the Contractor (more specifically, the Instrumentation supplier). When completed to the satisfaction of the Engineer, the facility can be placed on-line for live demonstration.
- F. Following successful completion of Facility commissioning, the Facility shall run successfully in full automatic mode for a period of 30 days for final acceptance

1.10 TURNOVER OF SPARE PARTS AND SPECIAL TOOLS

- A. Spare Parts
1. As soon as practical following Equipment Demonstration, the Contractor shall turn over all required spare parts, supplies and consumables specified in the Contract Documents. The Contractor shall also provide a list of additional items recommended by the manufacturer to assure efficient operation for a period of 1 year at the particular installation.
 2. The foregoing shall not relieve the Contractor of any responsibilities under the guarantee provisions of these Specifications.
- B. Special Tools
1. As soon as practical following start-up, the Contractor shall turn over one complete set of suitably marked special tools and appliances specified in the Contract Documents which may be needed to adjust, operate, maintain, or repair the equipment.
- C. Keys
1. The Contractor shall deliver four keys for each lockset and padlock installed under this Contract.
 2. The keys shall be tagged with locations, room numbers, and key numbers.
- D. Delivery
1. The Contractor, or Subcontractor, shall turn over all spare parts, special tools and keys to the Owner at one time in the original shipping container unopened.
 2. The approved Spare Parts list shall be used to document all items being turned over to the Owner. The Contractor and Owner shall open the shipping container and inventory each spare part and tool and mark the list as received.

3. The Contractor and Owner shall initial and date the list documenting that the spare parts, tools and keys were submitted and turned over to the Owner. Copies shall be provided to the Owner and Engineer.

1.11 TRAINING – GENERAL

- A. The Contractor shall provide training for all equipment where specified in Divisions 11 through 16. Training shall be a minimum of 6 hours - 2 hours for each of 3 shifts - for each equipment specification section unless otherwise noted. Training time does not include the time required for system startup/demonstration.
- B. Classroom and field training programs shall be conducted for each shift, after Start-up/Demonstration but prior to Substantial Completion.
- C. The Contractor shall submit resumes of the Manufacturer's representatives who will conduct the tests and training. Where additional testing consultants are required, such as vibration testing, or noise specialists, VFD technicians, etc. resumes for those representatives shall also be provided.
- D. Prepare and submit a Training Package 10 days prior to training.
- E. The Agenda shall include topics with durations for each topic, classroom, and field training, training materials/O&M manual, and hands-on training of all individuals requiring training.
- F. Incorporate the following maintenance and operation data and training services into the training program.
 1. Shop Drawings
 2. Equipment Operation and Maintenance Manuals.
 - a. Troubleshooting guides.
 - b. Preventive maintenance schedule.
 - c. Lubrication schedule.
 - d. Loop diagrams.
 - e. Control logic calibration sheets.
- G. All training materials and presentations must match the O&M manual. Occasionally, the training session(s) uncover discrepancies between the O&M Manual and the installed equipment. When this occurs, the Contractor shall resubmit corrected O&M documents.
- H. Where additional training is required at a later date, Contractor shall schedule a tentative future training session with the Owner.
- I. The Contractor shall provide a video tape of the Training Sessions. The video shall be performed by a Subcontractor specializing in this service.

1.12 ACCEPTANCE OF EQUIPMENT AND SUBSTANTIAL COMPLETION

- A. When equipment is identified for Substantial Completion, that equipment will be Substantially Complete following the successful completion of:
 1. Pre-Demonstration Procedures and Activities
 2. Start-up/Demonstration

3. Spare parts turnover
 4. O&M submittals
 5. Training
 6. Minimum run-time for equipment acceptance
- B. The Contractor is required to submit the Substantial Completion form for signatures.
- C. All documentation provided as a result of start-up shall be incorporated into the final O&M Manuals by the manufacturer's representative.
- D. Equipment, process areas or work that will be accepted for Substantial Completion are listed in Section 01950.

1.13 FACILITY COMMISSIONING SUBSTANTIAL COMPLETION

- A. Equipment is not identified for Substantial Completion and where a Facility, System or Phase of the work is identified for Substantial Completion, that facility, system or phase and all equipment therein will be Substantially Complete following the successful completion of:
1. Demonstration of all equipment (including spare parts turnover, training and final O&M Manual)
 2. Minimum run-time for equipment acceptance
 3. Facility Commission
 4. Facility or system training
 5. Minimum Facility run-time
- B. All documentation provided as a result of start-up shall be incorporated into the final O&M Manuals by the manufacturer's representative.
1. Substantial Completion for facilities, systems or phases of the work is listed in Section 01950.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION

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SECTION 01700

CONTRACT CLOSEOUT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section includes the necessary work and submittals necessary to close out the project.

1.2 RELATED SECTIONS

- A. Section 01300 - Submittals
- B. Section 01650 – Equipment/Facilities Start-up and Commissioning
- C. Section 01730 - Operation and Maintenance Data

1.3 SUBMITTALS

- A. Electronic file transfer of all project documents posted to the submittal's website. Files must be transferred before the website is discontinued
- B. Record Drawing Sets, from General Contractor, and Mechanical Electrical and Systems House Subcontractors
- C. Final Change Order
- D. Final Application for Payment
- E. Contractual Statements including:
 - 1. Waiver of Lien
 - 2. Contractor's Affidavit
 - 3. Contractor's Declaration
 - 4. Release of Surety.
- F. Manufacturers' Extended Warranties, Material and Guaranty Bond (if required).
- G. Copy of Occupancy Permit and any other permits from local governing authority (if required).
- H. Start-Up and Commissioning Documents
- I. Final O&M Manuals
- J. Construction Photographs and Video(s) where specified.

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1.4 CLOSEOUT PROCEDURES

- A. Submit statement certifying that all submittals have been “Accepted” and Contractor requirements are “None”.
- B. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's review.
- C. Perform satisfactory completion of Punch List.
- D. Submit final Application for Payment identifying Total Adjusted Contract Sum, previous payments, and sum remaining due.
- E. Provide satisfactory evidence that all claims have been settled.

1.5 FINAL CLEANING

- A. Complete final cleaning and restoration prior to final project inspection.
- B. Remove all temporary labels, stains, and foreign substances. Wash or clean by approved methods all surfaces on which dust and dirt has collected.
- C. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
- D. Clean debris from drainage systems.
- E. Clean site, sweep paved areas, rake clean landscaped surfaces.
- F. Remove waste and surplus materials, rubbish, and construction facilities from the site.
- G. Restore disturbed area. Lawn area may be seeded unless otherwise noted. Paved area shall be restored to their original condition, compatible with the surrounding area, using like materials and workmanship.
- H. Touchup painted surface. Clean and repaint with matching color all scratched, marred, or otherwise damaged painted surfaces of all equipment and enclosures.

1.6 ADJUSTING

- A. Adjust operating Products and equipment to ensure smooth and unhindered operation.

1.7 PROJECT RECORD DOCUMENTS

- A. Maintain As-Built set on site, with regular red-line markups by the General Contractor and Mechanical, Electrical and I&C Subcontractors. Note As-Built drawings are produced by the Contractor, and Record Drawings are produced by the Engineer.
- B. As the work progresses, keep a complete and accurate record of all changes in the Contract Documents indicating the work as actually installed. All changes shall be neatly shown on

prints of the drawings affected which shall be kept at the job site for inspection by the Owner and the Engineer.

- C. Record the location of existing buried utilities uncovered during the course of construction. Measure the location of the utilities from permanent structures or surface features
- D. Ensure entries are complete and accurate, enabling future reference by Owner. Record information concurrent with construction progress. Engineer to review progress monthly prior to approval of Pay application.
- E. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Measured depths of other floors, slabs, platforms, and foundations in relation to finish main floor datum.
 - 2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - 3. Measured locations of internal utilities, conduits, and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 - 4. Field changes of dimension, detail, and placement.
 - 5. Details not on original Contract drawings.
 - 6. Conduit and wiring information changed, or not shown on drawings including home runs.
- F. On completion of the work, prior to the Contractor's application for final payment, the Contractor shall scan and transfer the As-Built drawings and transfer them to the Engineer. The Engineer shall review these Drawings for completeness and accuracy and may require re-submittals.
- G. Written approval or other evidence satisfactory to the Engineer of the final conditions of the work shall be obtained from all public authorities or agencies having jurisdiction over any portion of the work.
- H. All public authorities or agencies having jurisdiction over any part of the work shall be determined, and all the requirements of these authorities or agencies with respect to but not limited to inspection, permits, fees, approval, and the like regardless of whether they are listed above or not shall be met.
- I. Submit all documents to Engineer for approval prior to submittal of final Application for Payment.

1.8 SATISFACTION OF CLAIMS

- A. Before final payment can be made, the Contractor shall furnish satisfactory evidence that all claims for damage have been legally settled, or sufficient funds to cover such claims have been placed in escrow, or that an adequate bond to cover such claims has been obtained to secure payment therewith interest.
- B. In the event that any Contractor has trespassed upon private property in the prosecution of the work of this contract, the Owner may withhold payment for the value of such work in or on

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the property, but in any case, no less than a sum of \$500 for each property trespassed until the Contractor has secured a release from the property owner upon whose property the trespass was committed.

1.9 SUBSTANTIAL COMPLETION

- A. Substantial Completion is the stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so the Owner can occupy and utilize the facilities for its intended use.
- B. Substantial Completion is covered under Section 01650-Equipment Start-Up and Commissioning.

1.10 WARRANTIES

- A. Assemble and provide all extended warranties (more than the project warranty period) all from subcontractors, suppliers, and manufacturers, dated to the date of Substantial Completion(s). Insert warranty documents into the Warranty tab Section of the O&M Manuals.
- B. Submit warranty documents prior to final Application for Payment.
- C. All parts of the work or equipment which is in the opinion of the Engineer prove defective in material, workmanship, or operation within the warranty period shall be removed and replaced or repaired in a manner satisfactory to the Engineer and at no cost to the Owner. Work so repaired or remedied will receive the same warranty period, starting at the date of the accepted re-work.
- D. Any service material or equipment required because of the defect shall be supplied without charge.
- E. All work specified to be designed by the Contractor shall be guaranteed to perform as specified.
- F. The general Warranty period is stipulated in ITB General Conditions, starting at the date of Substantial Completion unless:
 - 1. A greater period is specified elsewhere.
 - 2. Owner chooses to take over and use a portion of the Work as provided for in the Specifications; in which case the warranty shall be from agreed upon takeover and date of use.
- G. Equipment or work replaced and/or repaired during the warranty period shall be guaranteed for the additional warranty period from the date of acceptance of the repair or replacement or until expiration of the original warranty period whichever comes later.

1.11 FINAL PAYMENT

- A. Within thirty (30) days after the completion of the work under this Contract to the satisfaction of the Owner and the Engineer, in accordance with all and singular terms and stipulations herein contained, the Owner shall make final payment, from a final estimate made by the Engineer. Before final payment is made, the Contractor shall, as directed by the Owner,

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furnish a Contractor's Affidavit that he has paid or satisfactorily secured all claims of every nature. Also, the Contractor shall furnish a release from the surety or sureties and permit agencies as applicable, approving payment of final estimate by the Owner. The final payment, when made, shall be considered as final approval and acceptance of the completed work herein specified.

- B. The acceptance by the Contractor of the final payment aforesaid shall operate as, and shall be, a release to the Owner and his agents, from all claim and liability to the Contractor for anything done or furnished for, relating to the work, or for any act or neglect of the Owner or of any person relating to or affecting the work.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION 01700

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SECTION 01730

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Format and content of manuals.
- B. Instruction of Owner's personnel.
- C. Submittals.

1.2 RELATED SECTIONS

- A. Section 01300 - Submittals
- B. Section 01400 - Quality Control
- C. Section 01600 – Material, Products and Equipment
- D. Section 01650 – Equipment/Facilities Start-up and Commissioning
- E. Section 01700 - Contract Closeout
- F. Individual Specifications Sections: Specific requirements for operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Prepare instructions and data by personnel experienced in maintenance and operation of described products.
- B. Annotate all figures, arrangements, tables, charts, parts list, etc. specific to this application and the supplied equipment. Delete all superfluous information.

1.4 FORMAT

- A. Prepare information, data and drawings in the form of an instructional manual.
- B. Prepare in PDF format until finalized, then prepare in paper binder format. Print in color, text double sided, 11"x17" drawings single sided.
- C. Binders: Commercial quality, 8-1/2 x 11 inch three D side ring binders with durable plastic covers; 3-inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings. Fill binders to no more than 75% capacity.
- D. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; Owner, Operator, General Contractor and Engineer names, addresses and logos.

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- E. Print Project, Owner, and logo on the spine.
- F. Provide tabbed indexes for each separate product and system, with typed description of product and system.
- G. Text: Manufacturer's printed data on 20-pound paper.
- H. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold 11" x 17" drawings to fit.
- I. Arrange content by process flow under section numbers and sequence of Table of Contents of this Project Manual.

1.5 CONTENTS, GENERAL FOR EACH VOLUME

- A. Table of Contents: Provide title of Projects and the names, addresses, and telephone numbers of Engineer, Subconsultants, and Contractor in the heading. Next, provide a schedule of products and systems, indexed to content of the volume.
- B. Tabs: Add additional tabs for Warranty, Preventive Maintenance and Start-up and Commissioning documentation
- C. For Each Product or System: List names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- D. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information. Identify specific model numbers, size, etc.
- E. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
- F. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.
- G. A CMMS Data Entry Form is to be completed and submitted with the manuals. Form to be provided by the Engineer.

1.6 MANUFACTURERS MANUALS FOR EQUIPMENT AND SYSTEMS

- A. Provide serial number, order number or the specific ID of which the manufacturer can retrieve design files.
- B. Each Item of Equipment and Each System: Include description of unit or system, and component parts with diagrams, charts, capabilities, etc. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, complete nomenclature and model number of replaceable parts, and catalog data or literature with correct model number of equipment noted where literature covers more than one model.
- C. Provide general and product specific design data

- D. Provide manufacturer's detailed parts list and parts drawing, illustrations, assembly/disassembly drawings and instructions, and diagrams required for maintenance. Provide a cross reference to all individual component manuals for all parts lists and illustrations provide correct parts numbers. All bearing numbers shall be listed
- E. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications, either typed or by label machine.
- F. Include color coded wiring diagrams as installed.
- G. Shipping, storage maintenance and handling: Include all necessary off-loading requirements, and all necessary rotation, lubrication, heating, or other provisions required during storage.
- H. Include manufacturer's installation instructions including sequence, alignment, tolerances, torque settings, etc.
- I. Operating Procedures, include:
 - 1. Start-up, break-in, and routine normal operating instructions and sequences, including:
 - a. Manual Operation
 - b. Automatic Operation
 - 2. Regulation, control, stopping, shut-down, and emergency instructions.
 - 3. Trouble shooting for equipment and ancillary components
 - 4. Summer, winter, and any special operating instructions.
- J. Provide controls diagram and sequence of operation by controls manufacturer.
- K. Maintenance Requirements: Include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions and drawings; and alignment, adjusting, balancing, calibration and checking instructions.
- L. Provide preventive maintenance recommendations servicing and lubrication schedule, and list of lubricants required in the Preventive Maintenance tab. Provide Contractor's coordination drawings, with color coded piping diagrams as installed for equipment systems.
- M. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams for each equipment system.
- N. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage and how to obtain them.
- O. Additional Requirements: As specified in individual Product specification sections.
- P. Preventive Maintenance Tab, provide:
 - 1. PMs for all equipment, gear reducers, motors, and ancillary equipment, described throughout the O&M Manual.
 - 2. Reference to the page in the O&M Manual.
- Q. Start-up Tab Commissioning tab: Following Start-up include into PDF and printed O&M Manuals:
 - 1. Start-up documentation specified in Section 01650.

- 2. Functional and performance tests
- 3. Equipment baseline data
- 4. Any independent test agency tests and/or balancing reports as specified in Section 01400 and Divisions 11 through 16.

R. Warranties Tab: Following acceptance, include in PDF and Printed O&M Manuals warranty dated for Substantial Completion, or Owner agreed upon date.

1.7 INSTRUCTION OF OWNER PERSONNEL

- A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of products, equipment, and systems, at agreed upon times.
- B. For equipment requiring seasonal operation, perform instructions for other seasons.
- C. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- D. Prepare and insert additional data in Operation and Maintenance Manual when need for such data becomes apparent during instruction.
- E. Refer to individual equipment specification section for instruction and training requirements.

1.8 SUBMITTALS

- A. Submit Draft PDF prior to shipment for review.
- B. Submit Checklist and CMMS Data Entry Sheet provided by Engineer
- C. Submit Approved PDF and printed Manuals prior to equipment start-up. Approved copies will be used during training. Provide 3 printed manuals, or as required by Owner.
- D. Following Training, Startup, Commissioning and Substantial Completion, Revise content of all document sets where required following training and insert Warranties and Start-Up Documentation into printed binders and PDF and repost to submittals website.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF TEXT

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O&M MANUAL CHECKLIST

Note to Contractor: This form must be submitted with all O&M manuals.

Equipment Name _____

Specification Number _____

I, _____ do hereby certify that the O&M Manual for the referenced equipment:

(Print / Type Name) _____

meets requirements and specification for 01730 as noted below:

Format	<u>yes</u>	<u>no</u>		<u>yes</u>	<u>no</u>
Table of Contents:	<input type="checkbox"/>	<input type="checkbox"/>	Annotated Format:	<input type="checkbox"/>	<input type="checkbox"/>
Provide 3-Ring Binder:	<input type="checkbox"/>	<input type="checkbox"/>	Tabs:	<input type="checkbox"/>	<input type="checkbox"/>
Cover/Spine					
Equip. Title:	<input type="checkbox"/>	<input type="checkbox"/>	Owner:	<input type="checkbox"/>	<input type="checkbox"/>
Project Title:	<input type="checkbox"/>	<input type="checkbox"/>	Contractor:	<input type="checkbox"/>	<input type="checkbox"/>
Date:	<input type="checkbox"/>	<input type="checkbox"/>	Engineer:	<input type="checkbox"/>	<input type="checkbox"/>
			Representative:	<input type="checkbox"/>	<input type="checkbox"/>
			Manufacturer:	<input type="checkbox"/>	<input type="checkbox"/>
General					
Design Data:	<input type="checkbox"/>	<input type="checkbox"/>	Expanded Views:	<input type="checkbox"/>	<input type="checkbox"/>
Spare Parts List:	<input type="checkbox"/>	<input type="checkbox"/>	Complete Parts List:	<input type="checkbox"/>	<input type="checkbox"/>
Equip. Drawings:	<input type="checkbox"/>	<input type="checkbox"/>			
Operations:					
Handling & Storage:	<input type="checkbox"/>	<input type="checkbox"/>	Start-Up:	<input type="checkbox"/>	<input type="checkbox"/>
Installation Procedures:	<input type="checkbox"/>	<input type="checkbox"/>	Trouble Shooting:	<input type="checkbox"/>	<input type="checkbox"/>
Maintenance					
Maintenance Procedures:	<input type="checkbox"/>	<input type="checkbox"/>	Preventive Maint. Req.:	<input type="checkbox"/>	<input type="checkbox"/>
Lubrication Specs.:	<input type="checkbox"/>	<input type="checkbox"/>	Preventive Maint. Sched.:	<input type="checkbox"/>	<input type="checkbox"/>
Electrical					
Motor Data:	<input type="checkbox"/>	<input type="checkbox"/>	Control Wiring Diagram:	<input type="checkbox"/>	<input type="checkbox"/>
Wiring Diagrams:	<input type="checkbox"/>	<input type="checkbox"/>			
Test / Field Reports					
Balance Report:	<input type="checkbox"/>	<input type="checkbox"/>	Noise (dB) Readings:	<input type="checkbox"/>	<input type="checkbox"/>
Certif. of Installation:	<input type="checkbox"/>	<input type="checkbox"/>	Pressure Tests:	<input type="checkbox"/>	<input type="checkbox"/>
Miscellaneous					
Extended Warrantee:	<input type="checkbox"/>	<input type="checkbox"/>	MSDS Sheets:	<input type="checkbox"/>	<input type="checkbox"/>

Comments: _____

Signature _____

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SECTION 01900

SOIL CONDITIONS AND BORING LOGS

PART 1 GENERAL

1.1 SOIL CONDITIONS

- A. The Contractor is specifically referred to in the following items in the Contract Documents regarding soils information:
1. Specification 000_ITB– Instructions to Bidders
 2. Article 3 - Inspection of Site
Article 4 - Sub-Soil Conditions
 3. Section 01950 - Sequence of Construction and Special Project Requirements
 4. The location of the soil borings are indicated on the Drawings. The Geotechnical Investigation Report is included in the Appendix.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

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SECTION 01950

SEQUENCE OF CONSTRUCTION AND SPECIAL PROJECT REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL

- A. The Wastewater Treatment Plant (WWTP) treats sewage 24/7 and must remain in-service throughout construction. Wet weather and/or snow melt can cause significant increases to wastewater flow, necessitating additional equipment to be in service and staff to be unavailable to assist the Contractor, etc. As a result, some process construction areas may be vacated, and/or start-up and/or training activities may be curtailed or postponed in the event or anticipation of a rain event. This is deemed normal for WWTP construction, and no additional compensation will be made for these occurrences.
- B. The Contractor shall schedule and arrange his work so that each treatment and process area will remain in service, without interruption, unless stipulated herein, throughout construction. It is also imperative that access to all areas and equipment are continually provided unless otherwise stipulated herein, for the Owner to provide routine and emergency operations and maintenance.
- C. The Construction Schedule shall be developed to include the sequencing description presented herein. Alternate sequencing can be proposed, subject to the Owner's and Engineer's review and approval.
- D. The Contractor shall be responsible for the construction of the Project under scheduling conditions outlined herein and any other scheduling which may be necessary. All work shall be completed for the price submitted in the Contractor's proposal. No additional compensation will be allowed for delays in the work necessary to prevent interruption of service whether specifically spelled out in this section or not.

1.2 RELATED SECTIONS

- A. Section 01300 – Submittals
- B. Section 01310 – Construction Schedule
- C. Section 01650 – Equipment Start-Up and Facility Commissioning
- D. Section 01960 Pre-Construction Video
- E. Section 02050 – Demolition

1.3 SUBMITTALS

- A. System Integration Plan
- B. Sequencing including shutdowns shall be clearly delineated on the 01310 Construction Schedule Submittals.

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- C. Shut Down Notices for all shutdowns. (Owner / Engineer to provide the form)

1.4 COORDINATION

- A. The provisions contained herein, particularly the Sequence of Construction, shall be coordinated, and incorporated into the Construction Schedule.
- B. The Owner shall be notified at least 7 days in advance of any planned pump, tank, equipment, or electrical shutdowns, switchovers, or lockouts. All shut-downs will be granted at the discretion of the Owner.
- C. Other contractors are currently and will be on-site during the construction of this work. The bidding Contractor must cooperate with these other contractors. When necessary, the Contractor shall identify any cooperation activities with the Engineer or Owner.

1.5 EQUIPMENT OPERATION AND MAINTENANCE

- A. Existing facilities and equipment which are required to be in service during their modification will be operated and maintained by the Owner.
- B. New facilities and equipment which are required to be in service before they are completed and/or accepted by the Owner, will be operated and maintained by the Contractor.
- C. Operation of new or modified facilities by the Owner before these facilities are completed, tested, and accepted does not imply acceptance of these facilities by the Owner.
- D. New or modified facilities and equipment which have been accepted by the Owner as Substantially Complete, will be operated and maintained by the Owner as of the date of Substantial Completion.

1.6 TEMPORARY FACILITIES

- A. Any and all temporary structures, pumping, piping, electrical / instrumentation and control, or other construction required to maintain wastewater treatment in the existing facilities and to operate new facilities prior to completion of construction shall be furnished and installed by the Contractor.
- B. Temporary equipment and/or facilities, such as pumps, piping, flumes, valves and gates, electrical generators, etc. required for any wastewater treatment and/or conveyance will be sized, installed, operated, maintained, and removed by the Contractor.
- C. The Contractor shall provide required instructions for the operation of temporary facilities in writing to the Engineer. Temporary equipment utilized in the wastewater treatment process shall be operated 24 hours per day, if required to maintain the wastewater treatment process.
- D. The Contractor shall include in his bid and bear all expenses incurred, including temporary pumping and piping required to maintain wastewater treatment if such action becomes necessary during construction of new facilities.

1.7 SPECIAL PROJECT REQUIREMENTS

- A. The Contractor shall note that two screens manufacturers – Duperon and HydroDyne – are specified and details on the drawings. One manufacturer will be selected following the bid opening, and only those sheets applying to that manufacturer will apply. The other sheets and specifications will be deleted from the Issued for Bid Contract Documents.
- B. Contractor to provide:
1. Temporary heat (when necessary) to maintain a minimum of 45 degrees F.
 2. Exhaust ventilation a minimum of 6 air changes through-out construction
- C. Site Access
1. The Contractor shall comply with any daily personnel sign-in or orientation training requests by the Owner.
 2. Trailers, material laydown and other work logistics shall be confined to the staging area shown on the Drawings. The actual trailer siting and utility hookups shall be coordinated with the Owner following the pre-construction meeting.
 3. All personal vehicles shall be confined to the area shown on the Drawings. Construction vehicular traffic shall be confined to superintendents and/or foreman in company vehicles. All construction vehicles shall always have company logos and shall park in areas not effecting Owner vehicles or traffic.
 4. Plant traffic speed limits must be adhered to by all project personnel including deliveries.
 5. The Contractor must inform suppliers and install temporary signage that all deliveries must be made to the Contractor's trailers and not to the Owner. The Owner will not be responsible for lost deliveries.
 6. Owner's working hours are 7:00 am to 5:00 pm Monday through Friday. Staff will not be available after normal working hours nor weekends or holidays.
- D. Material Testing
1. All soil and concrete testing to be performed by third party testing company specializing in these services shall be included in the bid price.
 2. The Contractor shall arrange to have all soil compaction tests and concrete quality control including concrete compression tests and any ASR tests for aggregate performed. The material testing firm shall be approved by the Engineer.
 3. Concrete cylinder tests shall be as specified in Section 03300.
 4. Other Quality Assurance (QA) testing may be required and paid for via allowance.
 5. Copies of test reports shall be promptly posted and furnished to the on-site Engineer and Owner.
 6. Contractor to expressly identify non-conforming test results to the Owner / Engineer. Further work cannot proceed until the non-conforming test results are remedied.
- E. Maintain Road Traffic
1. The road must remain open for Owner operations and sludge hauling traffic.
 2. The Contractor shall accommodate all reasonable requests for the on-going sludge hauling contractor.
- F. Preconstruction Digital Video Survey
1. Contractor shall perform a preconstruction digital video survey of the site prior to any work to document the existing conditions.
 2. Use Construction Video Media, Inc., (800) 346-3342 or approved equal

1.8 UTILITIES

- A. The WWTP has potable water, industrial water (IW), process effluent water (PEW), hot water/steam (exposed and buried), natural gas, electrical power, alarms and controls and chemicals. These need to remain in service at all times unless identified herein and only with the approval of a Shut Down Notice.
- B. Contractor must maintain the seal and process water connection in all pumps and equipment during construction particularly during pipe replacement. If temporary pipe is required, the Contractor shall furnish, install, and remove.

1.9 USE OF THE OWNER'S OVERHEAD A-FRAME, MONORAIL OR CHAIN FALLS

- A. The Contractor is not permitted to use the Owners equipment.

1.10 ABBREVIATIONS

- A. Abbreviations and acronyms used in this document include the following:

CA	Compressed Air
CMMS	Computerized Maintenance Management System
WWTF	Downriver Wastewater Treatment Facility
H&V	Heating and Ventilation
IW	Industrial Water
LO/TO	Lock Out / Tag Out
MCC	Motor Control Center
PEW	Process Effluent Water
RPR	Resident Project Representative

- B. OTHER ABBREVIATIONS

- 1. Are listed on each legend drawing.

PART 2 – PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Demolition of key operational equipment cannot begin until replacement equipment is on-site, unless otherwise approved by the Owner / Engineer.
- B. All permanently installed materials and equipment including those installed for the purposes of construction sequencing, shall be in accordance with the applicable sections of these Specifications.
- C. Temporary materials and equipment including demolished materials shall be selected by the Contractor and shall conform to the intent of this Section.

PART 3 – EXECUTION (SEQUENCE OF CONSTRUCTION)

3.1 GENERAL

- A. Procedures and constraints set forth herein establish guidelines to construct the Work. This sequence shall not be construed as mandatory, nor shall the Contractor rely on it solely for the basis of determining sequencing as required to accomplish all of the work as shown on the Drawings or described in the specifications.
- B. The Contractor may use procedures other than those set forth herein with prior approval of the Engineer. The approval of the Engineer shall be only for compliance with the intent of maintaining full operation of the wastewater treatment facilities.
- C. Any variance to the sequencing presented herein does not relieve the Contractor from any costs to provide and maintain any or all temporary facilities and equipment that may be required to maintain plant operation during the construction period.
- D. The Contractor is responsible for the Schedule, Demolition, Staging, Sequencing, etc., required to complete the work in the time specified. Demolition Meetings to discuss sequencing and demolition will be held prior to construction.
- E. Shutdown notices are required for each area of the work requiring a utility, equipment, or process shutdown. No shutdown or demolition can begin until the replacement equipment, piping, valves, control panels, ancillary equipment etc. are stored or on-site, unless otherwise approved by the Owner / Engineer. Contractor to schedule and sequence any shutdowns to minimize the shutdown period. Lock out / tag out measures to be coordinated with the Owner.

3.2 CONDITIONS DURING SEQUENCING

- A. Plant Flow.
 - 1. As a means to provide Contractors with approximate historical flow rates to help gauge operations, the following is offered.
 - Dry Weather Low Flow 14-16 MGD
 - Dry Weather Average Flow 18-22 MGD
 - 'Typical' Wet Weather Flow 25-35 MGD
 - Peak Wet Weather Flow 60 MGD
 - 2. Actual flow data will be provided to the selected Contractor if required for further assessment.

3.3 GRIT AND SCREENINGS REMOVAL

- 1. The grit tanks, channels, piping, equipment, etc. will contain grit, screenings, sludge, and/or other wastewater materials typical of all WWTPs. The channels see velocities higher than 2 fps, and grit is removed from the grit chambers by the current grit equipment which is functioning. However, grit may be present in quantities of up to 6 inches on average in the channels. Contractor can hose the grit from the screening channels into the grit tank for pumping and processing. Any remaining grit must be removed by the contractor.
- 2. Contractor shall flush, pump, remove, clean areas of wastewater and materials as necessary to perform the work. Screenings can be disposed upstream of an operational screen, and grit can be discharge into an operational grit chamber.

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3.4 HEADWORKS SCREEN CONSTRUCTION SEQUENCING

- A. The Owner will isolate one screen channel at a time, for the Contractor to then demolish existing equipment and to install the new equipment.
- B. Owner will isolate the South Screen Channel first. The North Screens 1 and 2 will remain in operation, including the bypass channel. Contractor to perform all related work to the south channel, including start-up, commissioning and performance testing of the screen, sluice and screenings washer / compactor and slide gate repairs (see below).
- C. Slide Gate Repair
 - 1. There is no know information from the manufacturer on these gates regarding the seats and seals.
- D. Install the manual bar screens in the overflow channel.
- E. Once the manual bar screens and Screen No. 3 is Substantially Complete, the Owner to isolate the north Screens Nos. 1 and 2 for construction. Contractor to perform all related work to these gates and screens including the sluice, washer / compactors and all related equipment, controls, etc.

3.5 SLIDE GATE REPAIR

- A. South Channel:
 - 1. Contractor to sand-bag or bulkhead Gates F-8-1 and F-8-2 to minimize leakage.
 - 2. Contractor to dismantle Gates F-8-3 and F-8-4 to confirm the seal and seal replacement parts and the condition of the gate members and grout bed. (This work will be done in the presence of and in cooperation with the Engineer.) It is assumed that the replacement products will also be installed on the remaining gates. (See Section 11283)
 - 3. Contractor to temporarily bulkhead upstream of Gates F-8-1 and F-8-2 as needed for those seat repairs and all downstream gates.
 - 4. Contractor to temporarily bulkhead Gates F-6-3 and R-9-1 as needed for Gate F-8-6 repairs.
 - 5. Contractor to temporarily bulkhead upstream of Gates F-8-1 and F-8-2 for those seat repairs.
- B. Emergency Channel:
 - 1. Contractor to temporarily bulkhead upstream of Gates F-6-1 and sandbag Gates F-6-4 and F-7-1 as needed for gate repairs.
- C. North Channel:
 - 1. Contractor to temporary sandbag or bulkhead Gate F-4-1 and F-4-2 for downstream gate repairs.

3.6 HEADWORKS GRIT CONSTRUCTION SEQUENCING

- A. The Owner will isolate one grit tank at a time to allow contractor to demolish existing equipment and to install the new equipment.

- B. The North Grit Tank work can proceed concurrent with Screen work.
- C. Owner will isolate the North Grit Tank first. Once isolated:
 - 1. The Contractor shall then demolish the North Grit Tank equipment, associated grit washer, pumps, panels and electrical work, select removal of grating and concrete slab above tank, building exterior wall, alcove concrete etc.
 - 2. All equipment associated with the South Grit Tank shall remain in service, including the platform supporting the grit washers.
 - 3. Temporary walls, partitions and/or enclosures are required to isolate the building interior. The means to provide the isolation are considered means and methods but must be approved by the Engineer.
 - 4. Contractor to relocate slurry cup discharge while alcove structural work is ongoing.
 - 5. Contractor to install all grit equipment, pumps, concrete, tank covers and structural work, electrical and controls, overhead door, and any remaining North Grit Tank work.
 - 6. Contractor to perform start-up, equipment commissioning and performance testing to achieve Substantial Completion.
 - 7. Following a successful 30 calendar day demonstration period, the Owner will isolate the South Grit tank.
- D. Owner will isolate the South Grit Tank and the remaining grit work can be performed in a similar manner as that described for the North Grit Chamber. Contractor to coordinate and time the start of the south channel to the completion of the Odor Control Building to minimize south channel downtime.

3.7 ODOR CONTROL AND GRIT PUMP BUILDING

- A. This work can proceed independent from the Screens and North Grit equipment installation.
- B. When possible, re-install the exterior stairs.

3.8 HVAC REPLACEMENT

- A. Contractor to coordinate roof-top H&V unit installation with other work.
- B. Proper heating and ventilation is required throughout construction. When required, Contractor to provide temporary H&V.

3.9 ELECTRICAL

- A. Contractor shall submit detailed plan to keep critical loads powered throughout MCC-C and MCC-D decommission and replacement.
- B. MCC-C shall be replaced first. North Grit Tank equipment and the South screen equipment will be replaced first, see sequence above. The buckets in MCC-C associated with this equipment shall be de-energized and removed. The buckets in MCC-D associated with this equipment shall be de-energized and become spare. Critical loads in MCC-C shall be temporarily fed from MCC-D utilizing existing buckets or providing additional buckets in MCC-D or moving MCC-C buckets to MCC-D. Utilize temporary cabling as required.

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- C. Critical loads in MCC-C include Lighting Panel C, Sump Pump (N. Garage Basement), Sump Pump N. Garage Ground Floor, Grit/Slurry Pump No. 3, Bar Screen No. 1, Bar Screen No. 3, Screw Conveyor, Screenings Compactor No. 1, Grit Blower No. 3. (Note that some of these loads may be de-energized due to replacement, depending on the construction schedule. De-energized loads due to replacement do not need to be temporarily fed).
- D. After all critical loads are removed from MCC-C, de-energize MCC-C and remove. Existing wiring to MCC-C shall be marked and bundled, to be reused where required.
- E. Install DP-C and new motor starters and commission. Move loads temporarily fed from MCC-D to DP-C.
- F. The South Grit Tank equipment and the Center screen equipment will be replaced next, see sequence above. The buckets in MCC-D associated with this equipment shall be de-energized and removed. Remaining critical loads in MCC-D shall temporarily be fed from DP-C utilizing spare breakers or providing spare breakers as required. Utilize temporary cabling as required. Where new motor starters are required, these shall be installed and utilized.
- G. Critical loads in MCC-D include Lighting Panel D, Screenings Conveyor, Shaftless Screw Conveyor, Screw Conveyor, Sump Pump No. 2 North Alcove Basement, Sump Pump No. 2 North Garage Ground Floor, Screenings Compactor No. 2, Screenings Compactor No. 3, Grit Blower No. 2, Grit/Slurry Pump No. 1, Grit/Slurry Pump No. 2, Grit/Slurry Pump No. 4, Bar Screen No. 2, Channel Air Blower, Grit Dewatering Unit No. 1, Grit Dewatering Unit No. 2, Heat Recovery Unit (Note that some of these loads may be de-energized due to replacement, depending on the construction schedule. De-energized loads due to replacement do not need to be temporarily fed).
- H. After all critical loads are removed from MCC-D, de-energize MCC-D and remove. Existing wiring to MCC-D shall be marked and bundled, to be reused where required.
- I. Install DP-D and commission. Move loads temporarily fed from DP-C to DP-D.

3.10 SCADA INTEGRATION GENERAL

- A. System Integration Plan is required to decommission the existing system and install and integrate the new system.

3.11 SUBSTANTIAL COMPLETION

- A. Substantial Completion will occur under the following, and warranties will begin when the Substantial Completion requirements are met.
 - 1. South Screen, including demolition, screen installation, sluice, screenings washer / compactor, mezzanine and miscellaneous steel, architectural work, all power, controls, instruments, alarms and SCADA upgrades.
 - 2. North Screens Nos 1 and 2, including demolition, screen installation, sluice for both screens, screenings washers / compactors, mezzanine and miscellaneous steel, architectural work, and all power, controls, instruments, alarms and SCADA upgrades.

3. North grit removal system, including demolition, grit collector, grit pump and grit washer installation, piping and valving, supports, platform, power, controls, instruments, alarms and SCADA upgrades.
4. South grit system, Odor Control and Grit Pump Building, including:
 1. South grit removal system, including demolition, grit collector, grit pump and grit washer installation, piping and valving, all power, controls, instruments, alarms and SCADA upgrades.
 2. Odor Control equipment, including blowers, ductwork, carbon vessels, all power, controls, instruments, alarms and SCADA upgrades.
 3. Odor Control and Grit Pump Building, including all civil, structural, architectural, process, mechanical and electrical work not included in items 1 or 2 above.

END OF SECTION

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SECTION 01960

COLOR AUDIO-VIDEO SURVEY

PART 1 GENERAL

1.1 GENERAL.

- A. The Preconstruction Audio-Video (A-V) is required to record and document the existing conditions prior to the start of construction.
- B. The Contractor shall engage the services of a professional videographer actively engaged in audio-video recordings of projects similar to the work included under this Contract.

1.2 QUALITY ASSURANCE

- A. The firm shall have at least 10 year performing videography of work similar in nature and scope. The videographer shall have at least 5 years of professional experience in performing work of similar scope and magnitude.
- B. Provide references for the firm and videographer and his/her resume.
- C. The firm performing this work shall have the equipment and experience necessary to produce Full HD 1920 x 1080 audio-video recordings.
- D. The Engineer may require the video taping of a "sample" to verify the ability of the videographer to perform the work.

1.3 SUBMITTALS

- A. Submit digital recordings per 01300
- B. Submit separate A-V recordings for the following:
 - 1. Headwork, Interior
 - 2. Headworks, Exterior including roof and H&V equipment
 - 3. Civil / Site
- C. All digital recordings and written records shall become the property of the Owner. The firm performing this work shall also provide one complete copy of all DVD discs and written records to the Engineer.

PART 2 PRODUCTS

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PART 3 EXECUTION

3.1 VIDEO

- A. Coverage shall include the entire project area and buildings impacted by construction and any portions of streets to be used by the Contractor as access roads and/or haul roads.
- B. Contractor to first familiar him/herself with the nature and various disciplines of the work.
- C. A pre- A-V meeting can be held with the Engineer / Owner / Contractor to confirm the expected outcome of the recording.
- D. All recordings shall be done during times of good visibility and limited wind. No recording shall be done during periods of visible precipitation, or when more than 10% of the ground area is covered with snow or standing water, unless otherwise authorized by the Owner. Wind effected audio will be rejected. Any recorded coverage not acceptable to the Owner shall be rerecorded at no additional charge.
- E. The recording shall be done prior to placement of materials or equipment on the construction area and the files must be posted one week prior to the start of construction.
- F. All recordings shall identify location, time, and date in a manner acceptable to the Owner.
- G. If conventional wheeled vehicles are used for the Civil recording, the distance from the camera lens to the ground shall not be less than twelve (12) feet to insure proper perspective. The rate of speed in the general direction of travel of the conveyance used during recording shall not exceed 30 feet/minute. Panning rates and zoom-in, zoom-out rates shall be controlled sufficiently such that stop-action during play-back will produce clarity of detail in the object viewed.
- H. Supplemental light will be required for indoor areas that have mercury-halogen lighting. Contractor to discuss lighting with the Owner and/ or survey the galleries, dry wells, lower levels, etc. of the facility.
- I. Videographer is not required to enter any confined spaces. Areas not requiring videography include:
 - 1. Screen channels (inside)
 - 2. Grit Tanks (inside)

3.2 AUDIO

- A. Audio shall be clear, loud, and include:
 - 1. Videographer, Firm, Date, Time Weather
 - 2. Type of Work (e.g., Structural)
 - 3. Area of the WWTP
 - 4. Orientation towards North (include video orientation, confirm north orientation periodically through galleries)
 - 5. Other aspects of the area that require clarification or further detail.

END OF SECTION

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SECTION 02050

DEMOLITION WORK

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Building / Concrete structure demolition.
- B. Selective demolition of building elements for alteration purposes.
- C. Selective demolition of mechanical equipment.
- D. Selective demolition of electrical equipment.
- E. Selective demolition of architectural items.
- F. Abandonment, removal, and/or connection to existing utilities and utility structures.
- G. Salvage of existing items to be reused or delivered to Owner.

1.2 GENERAL REQUIREMENTS

- A. Demolition work shall be executed in an orderly and careful manner, with due consideration for neighbors and the public.
- B. All work shall be performed per all governing laws and regulations, including all current OSHA Standards.
- C. The Contractor shall obtain all necessary permits for the work.
- D. The cost of all permits shall be included as part of the bid.
- E. It is the intent of this Section that the Demolition Work shall be complete whether or not specifically specified herein or shown on the Drawings, and all costs associated with the Demolition Work shall be included in the bid price.

1.3 RELATED REQUIREMENTS

- A. Specification 01950 – Sequence of Construction
- B. Division 15000 – Mechanical
- C. Specification 16010 – Electrical, Instrumentations & Controls Requirements

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1.4 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Detach items from existing construction and deliver them to Owner ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled. Items to remain shall be protected from damage throughout construction at no additional cost to the Owner. Protected items that damaged due to construction activities are to be replaced at no additional cost to the Owner.

1.5 SUBMITTALS

- A. Submit in accordance with Section 01300 - Administrative Requirements, and the General and Supplementary Conditions.
- B. Provide a demolition plan for review by the Engineer and Owner prior to commencing demolition work.
- C. Furnish a detailed sequence of demolition and removal work to ensure the uninterrupted progress of Owner's operations. Sequence shall be compatible with overall work sequence of construction.
- D. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction

1.6 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: Company specializing in the type of work required.
- B. The Michigan Building Code shall control the demolition, modification or alteration of the existing buildings or structures.

1.7 PROJECT CONDITIONS

- A. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.
- B. Protection. Erect and maintain barriers, lights and other protective devices to prevent access to areas under construction or within the influence of the ongoing work. Provide free and safe passage to and from adjacent structures which are being used by the Owner for ongoing operations of the lift station.

- C. The Owner and ENGINEER assume no responsibility for the actual condition of the structures/equipment to be demolished or modified. Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner insofar as practicable. However, variations within a structure may occur prior to the start of demolition work.
- D. Repairs to Damage. Promptly repair damage caused to adjacent facilities by demolition operation when directed by the ENGINEER at no cost to the Owner. Repairs shall be made to a condition at least equal to that which existed prior to construction.
- E. The Contractor shall be responsible for the testing, handling, removal, storage and disposal of any materials suspected to contain lead or asbestos. All testing, handling, removal, storage and disposal of lead or asbestos materials shall be performed in a manner that meets all Federal, state and local laws and regulations. The cost for testing for the presence of lead or asbestos containing materials, monitoring for permissible exposure limits during construction, and abatement shall be included in the Total Contract Lump Sum Price. The Contractor shall be completely responsible for environmental mitigation and the safety and protection of all labor forces and Owner(s) personnel due to means and methods chosen that may exacerbate harmful lead or asbestos conditions, such as torch-cutting painted surfaces and other standard demolition practices.
- F. The Contractor shall provide and install all necessary shoring and bracing required to support walls and other parts of existing buildings during demolition. All Contractor installed fences, barricades, shoring, etc. not essential for the further protection of property or personnel at the completion of the demolition work shall be removed by the Contractor.
- G. No materials shall be dropped or chuted from any height which might endanger personnel or adjacent property. Dynamite or other explosives shall not be used at any time in performing the work described herein. No open burning of debris and rubbish will be permitted.
- H. Before doing any offsite dumping, the Contractor shall make all necessary arrangements, obtain written permission, secure permits, and pay all charges and fees, as required. The Owner assumes no liabilities for offsite dumping.

1.8 CONTRACTOR'S SUPERVISION

- A. Contractor's responsibility shall include a completely equipped first aid kit, provided and maintained at the site in a clean orderly condition and shall be readily accessible at all times to all the Contractor's employees.
- B. The Contractor shall designate certain employees who are properly instructed to be in charge of first aid. At least one such employee shall be available whenever work is in progress at the demolition site.
- C. Telephone call lists for summoning aids from outside sources, such as doctors, ambulances, pulmotor and rescue squads, shall be conspicuously posted at the site.

1.9 STORAGE OF MATERIALS

- A. The Contractor shall be entirely responsible for his materials and equipment stored on the site pending disposal.

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- B. All materials not mentioned herein as remaining the property of the Owner, shall become the property of the Contractor, and shall be removed from the premises.
- C. All rubbish and debris resulting from the demolition operations shall be removed promptly as accumulated.
- D. There shall be no retailing of used materials at the site except as allowed by written permission from the Owner.
- E. The time schedule established shall include the removal from the site of all material, debris, and Contractor's equipment.

1.10 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

PART 2 PRODUCT

NOT USED

PART 3 EXECUTION

3.1 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.
 - 2. Comply with applicable requirements of NFPA 241.
 - 3. Use of explosives is not permitted.
 - 4. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - 5. Provide, erect, and maintain temporary barriers and security devices.
 - 6. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
 - 7. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 - 8. Do not close or obstruct roadways or sidewalks without permit.
 - 9. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.
- B. Do not begin removal until receipt of notification to proceed from the Owner.
- C. Removed and Salvaged Items:
 - 1. Coordinate salvaged items removal with Owner for turnover.

2. Remove and clean salvaged items.
 3. Transport items to Owner's storage area on-site.
 4. Protect items from damage during transport and storage.
- D. Removed and Reinstalled Items:
1. Coordinate salvaged items removal with Owner for turnover.
 2. Remove and clean salvaged items.
 3. Repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
 4. Protect items from damage during transport and storage.
 5. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated
- E. Protect existing structures:
1. Provide bracing and shoring as needed
 2. Prevent movement or settlement of adjacent structures.
 3. Stop work immediately if adjacent structures appear to be in danger.
 4. No jackhammering or other destructive methods of construction shall be used in areas where adjacent facilities which are to remain, and which may be damaged by such operations exist unless approved prior by ENGINEER.
- F. Partial Removal of paving, concrete structures, and curbs:
1. Neatly cut at a right angle to surface.
 2. Coordinate with DS sheets for additional tank interior selective demolition.

3.2 EXISTING UTILITIES

- A. Coordinate work with Owner, utility companies and local governmental agencies; notify before starting work and comply with their requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least seven (7) days prior written notification to Owner.
- E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least three (3) days prior written notification to Owner.
- F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.
- G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

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- H. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone; identify and mark utilities to be subsequently reconnected, in same manner as other utilities to remain

3.3 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Drawings showing existing construction and utilities are based on field observation, existing record document, and laser scan 3D models.
 - 1. Verify that construction and utility arrangements are as shown.
 - a. Tank interior dimensions must be field verified due to datum differences between existing drawings.
 - 2. Report discrepancies to Engineer before disturbing existing installation and indicate on record drawings.
 - 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
 - 4. When general items are noted for demolition, it is assumed that appurtenances and incidental items associated with the general item should also be demolished and removed.
- B. Separate areas in which demolition is being conducted from other areas that are still occupied.
 - 1. Provide, erect, and maintain temporary dustproof partitions of construction where required.
- C. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage. Prevent freezing temperatures from occurring in areas of the Headworks which are in use while work is ongoing. Maintain a minimum temperature of 40F in all areas where are being used by the Owner for operations or higher temperatures, if necessary, to operate remaining equipment.
- D. Remove existing work as indicated and as required to accomplish new work.
 - 1. Remove items indicated on drawings. Where piping or electrical lines are removed back to a functioning point, cut/cap/properly terminate the remaining functioning component.
 - 2. When pipes, conduits other equipment are removed, all fasteners for that equipment shall also be removed and all holes/damage to the existing structures from which the equipment was attached shall be filled and repaired with like materials.
- E. Mechanical/Electrical (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications):
 - 1. Remove existing systems and equipment as indicated in drawings.
 - 2. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
 - 3. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and accepted for service.
 - 4. Verify that abandoned services serve only abandoned facilities before removal.
 - 5. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.

6. Where vents or other pipes/conduits that are to be removed pass through an existing roof/floor/wall that is to remain, the resulting hole in the roof/floor/wall shall be patched and made watertight to match the existing materials.
 7. All existing electrical equipment and fixtures to be removed shall be removed with such care as may be required to prevent unnecessary damage, to keep existing systems in operation and to maintain the integrity of the grounding systems.
 8. Conduits and wires shall be abandoned or removed where shown. All wires in abandoned conduits shall be removed and disposed of off-site as required.
 9. Abandoned conduits concealed in floor or ceiling slabs or in walls, shall be cut flush with the slab or wall at the point of entrance. The conduits shall be suitably plugged and the area repaired in a flush, smooth and approved manner. Exposed conduits and their supports shall be disassembled and removed from the site.
- F. Protect existing work to remain.
1. Prevent movement of structure; provide shoring and bracing if necessary.
 2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
 3. Repair adjacent construction and finishes damaged during removal work.
 4. Patch as specified for patching new work.
- G. Building/Structure demolition.
1. Demolish concrete in small sections.
 2. Remove structural framing members and lower to ground by means of hoists, derricks, or other suitable methods.
 3. Remove structures to the lines and grades shown unless otherwise directed by the ENGINEER. Where no limits are shown, the limits shall be 4-inch outside the item to be installed. The removal of masonry beyond these limits shall be at the Contractor's expense and these excess removals shall be reconstructed to the satisfaction of the Engineer with no additional compensation to the Contractor.
 4. After removal of parts of all of walls, slabs and like work which tie into new work or existing work, the point of junction wall be neatly repaired so as to leave only finished edges and surface exposed.

3.4 DEMOLITION SCHEDULE

- A. Removed and Salvaged Items:
1. Headworks Building roof exhaust fans (3 fans and 1 makeup air unit)
 2. Grit JIB cranes (4 total)
 3. Headworks Building grating as indicated on drawings.
 4. Influent Flow Splitter grating as indicated on drawings.
 5. Screening ultra-sonic level sensors (6 total)

These items are to be carefully salvaged and turned over to the Owner.

- B. Removed and Reinstalled Items:
1. Headworks Building grating as indicated on drawings.
 2. North Garage Screening Washer Compactor Support Platform as needed.
 3. Exterior stairs

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- C. Elements to Remain and be Protected:
 - 1. South Garage Screening Washer Compactor Support Platform as needed.
 - 2. All HVAC Equipment
 - 3. Electrical elements not indicated on the drawing for removal.
 - 4. South Garage Screening Washer Compactor Support Platform as needed.

3.5 DEBRIS AND WASTE REMOVAL

- A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an approved landfill.
- B. Do not allow demolished materials to accumulate on-site.
- C. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- D. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
- E. Leave site in clean condition, ready for subsequent work.
- F. Clean up spillage and wind-blown debris from public and private lands.

3.6 CLEANING

- A. The Contractor shall clean existing surfaces as required to perform the Work including tanks, wells, channels, floors, walls, etc.
- B. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition existing before demolition operations began.

END OF SECTION

SECTION 02110

SITE CLEARING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Removal of surface debris.
- B. Removal of paving, curbs, and gravel roadway materials, as required.
- C. Removal of trees, shrubs, and other plant life, including root system.
- D. Topsoil excavation and stockpiling.

1.2 RELATED SECTIONS

- A. Section 01005 - Administrative Provisions
- B. Section 02200 – Earthwork
- C. Section 02220 - Soil Erosion Control
- D. Section 02958 - Special Landscape Requirements for Site

1.3 REGULATORY REQUIREMENTS

- A. Conform to applicable code for disposal of debris.
- B. Coordinate clearing Work with utility companies.

1.4 SITE INFORMATION

- A. The Contractor shall be held to have compared the conditions of the site where work is to be performed with the drawings and specifications and to have satisfied himself as to the conditions of the site, existing conditions, and any other conditions affecting the carrying out of the work, before delivery of his proposal. It is expressly understood that he will obtain first hand information concerning the available facilities for receiving, transporting, handling and storing construction equipment and materials and concerning other local conditions that may affect his work.
- B. The contractor shall draw his own conclusions as to soil conditions, including possible presence of groundwater, to be encountered, and he shall complete the work under any job or field condition which was present and/or ascertainable prior to bidding.
- C. He shall also complete the work under whatever conditions he may create by his own sequence of construction, construction methods, or other condition he may create at no additional cost to the Owner.

- D. No allowance or extra consideration on behalf of the Contractor will subsequently be allowed by reason of error or oversight on the part of the Contractor.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 WORK INCLUDED

- A. The work included under this section consists of providing all labor, equipment and services to execute all items of clearing, demolition, soil erosion control and removal as shown on the drawings, including all incidental work obviously required to effect complete work to the full intent of the drawings and specifications.

3.2 PREPARATION

- A. Verify that existing plant life designated to remain is tagged or identified.
- B. Identify the waste area for disposing of removed materials off site.

3.3 PROTECTION

- A. Locate, identify and protect utilities that remain, from damage.
- B. Protect trees, plant growth, and features designated to remain as final landscaping.
- C. Protect bench marks, survey control points, and existing structures from damage or displacement.

3.4 CLEARING

- A. Clear areas required for access to site and execution of Work, as shown on the Contract Drawings.
- B. Remove trees and shrubs as indicated. Remove stumps, roots, and other debris to depths indicated on the Drawings and in Section 02958 of these Specifications.
- C. Clear undergrowth and deadwood, without disturbing subsoil.
- D. Remove topsoil and grass as indicated.

3.5 REMOVAL

- A. Remove debris, rock and extracted plant life from site, and dispose of in accordance with all Federal, State and Local Ordinances.

- B. Removing paving, curbs, and gravel base, as required, and dispose of off site. Neatly saw cut edges at right angle to surface.
- C. Do not burn any waste material.
- D. All combustible materials resulting from the clearing and grubbing operations shall be removed promptly from the site to a solid waste disposal site properly licensed under the latest revision, Act 87 of the Public Acts of 1965 of the State of Michigan. No open burning of debris or rubbish will be permitted at the site.

3.6 TOPSOIL EXCAVATION

- A. Excavate or strip topsoil from cleared areas without mixing with foreign or underlying materials.
- B. Do not excavate wet topsoil.
- C. Stockpile in area designated on site or off site as approved by the Engineer; construct piles to drain freely, and protect from erosion.
- D. Remove excess topsoil not intended for reuse from site.

END OF SECTION

SECTION 02140

DEWATERING

PART 1 GENERAL

1.1 GENERAL

- A. All dewatering, well pointing, pumping, bailing and cleaning shall be performed that is necessary to complete the work as specified and as shown on the Drawings under this Contract.
- B. The Contractor will be held to have compared the conditions of the site where work is to be performed with the Drawings and Specifications and to have satisfied himself as to the conditions of the site, existing conditions, and any other conditions affecting the carrying out of the work, before delivery of his proposal. It is expressly understood that he will obtain first hand information concerning the available facilities for receiving, transporting, handling and storing construction equipment and materials and concerning other local conditions that may affect his work.
- C. The Contractor shall draw his own conclusions as to soil and groundwater conditions to be encountered and he shall complete the work under any job or field condition which was present and/or ascertainable prior to bidding.
- D. He shall also complete the work under whatever conditions he may create by his own sequence of construction, construction methods, or other condition he may create at no additional cost to the Owner.
- E. The Contractor shall be solely responsible for evaluating the suitability of his dewatering methods with the Plans, Specifications and Soil Information provided by the Owner for bidding purposes. The Contractor shall also obtain County records as to the depth of wells providing water to the community or private individuals within the area affected by the dewatering operation if this information is not included in the Contract Plans or Specifications. The Contractor shall be prepared to supply potable water within forty-eight (48) hours to all parties affected by the dewatering operations and shall continue supplying water for a period of thirty (30) days after ceasing dewatering operations. All costs associated with the supplying of water shall be incidental to the work as bid.

If the affected parties remain without water thirty (30) days after ceasing dewatering operations, the supplying of water and resolution of the problem will be addressed by the Owner of this project.

- F. No allowance or extra consideration on behalf of the Contractor will subsequently be allowed by reason of error or oversight on the part of the Contractor.
- G. All work shall be done in a thorough and workmanlike manner and in conformance with accepted good practices and all requirements of local, state, and federal authorities having jurisdiction.

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- H. The requirements of the Soil Erosion Control Permit and the Wetlands Permit shall be adhered to at all times.

1.2 RELATED SECTIONS

- A. Section 01000 - General Specifications
- B. Section 01900 - Soil Conditions and Boring Logs
- C. Section 02220 - Soil Erosion Control

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 REMOVAL OF WATER

- A. Ample means and devices shall be provided and maintained at all times during the life of this Contract to remove and properly dispose of all ground water and drainage water within, around, and entering the excavated area. The excavation and the structures within shall be kept dry until the work is completed, or as approved by the Owner.
- B. The water level within and below work areas shall be so maintained that there is no unbalanced upward pressure on the bottom of structures, sewers, or open excavations during the construction period. The Contractor shall provide means within the excavation to enable the Owner to monitor the elevation of the artesian groundwater, if present. The level of the artesian groundwater shall be maintained by the Contractor's methods to prevent the possibility of upward movement of the structure or earth within the excavation area. Water levels shall be maintained to meet the approval of the Owner.
- C. In addition, water that may occur during excavation for base slabs, pipe trenches, etc., shall be channeled to accumulate in certain low points and disposed of through a filtering device before entering into sewers, streams, or rivers in accordance with Section 02220 – Soil Erosion Control, the Soil Erosion Control Permit, and as specified by the MDNR.
- D. The Contractor shall determine the extent of dewatering required to complete the work, and shall include all dewatering costs as incidental to the work as bid, unless provided otherwise in the Proposal.
- E. Dewatering as determined necessary by the Contractor to maintain work areas dry shall be continuous until the perimeter drain system, when required, is fully operational. The Contractor's dewatering equipment shall remain in place an additional thirty (30) days to verify operation of the perimeter drain system.

All excavation dewatering shall be routed as necessary so as not to impede construction. In any event, all pumping and drainage shall be done without damage to any other property,

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public or private, and without interference with the rights of the public or private property owners. The Contractor shall review soil information provided under Section 01900 - Soil Conditions and Boring Logs. This information may be used as an aid to the Contractor in determining the screen material necessary for well points or relief wells to prevent the removal of soil fines with the water removed. All pumping and drainage shall comply with Section 02220 - Soil Erosion Control and with the requirements of the Soil Erosion Control Permit.

- F. The Contractor shall receive no extra compensation for providing, maintaining or operating any dewatering or drainage facilities. The removal or stoppage of artesian water which, if any, might occur in the work shall be deemed to be covered by this Section of the Specifications unless provided for otherwise in the Proposal.
- G. On completion of this project the Contractor shall fill all dewatering depressions and withdraw all dewatering facilities and drainage devices and restore the area to an acceptable condition, as approved by the Owner.

END OF SECTION

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SECTION 02200

EARTHWORK

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. General
- B. Site Preparation
- C. Excavations
- D. Unauthorized Excavation
- E. Subgrade
- F. Slopes, Bracing
- G. Backfill
- H. Flowable Fill
- I. Finish Grading

1.2 RELATED SECTIONS

- A. Specification 000_ITB – Instructions to Bidders
- B. Section 01400 - Quality Control
- C. Section 01500 - Construction Facilities
- D. Section 01900 - Soil Conditions and Boring Logs
- E. Section 02201 – Monitoring Vibrations
- F. Section 02110 - Site Clearing
- G. Section 02140 - Dewatering
- H. Section 02220 - Soil Erosion Control

1.3 GENERAL

- A. All excavation and backfilling shall be performed that is necessary to complete the work under this Contract. Excavation shall include the loosening, loading, removing, transporting, stockpiling, and disposing of all materials of every sort, necessary to be removed for purposes

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of construction; the furnishing, placing, and maintaining of all bracing, and timbering; the care of existing roads, existing structures, utilities; and all incidental and collateral work necessary to complete the entire work as specified and as shown on the Drawings.

- B. Backfilling shall include the filling of the excavated and void spaces around and over the outside of completed structures and pipes. It is also the intention of these specifications to provide that backfill shall be so compacted that no appreciable subsequent settlement will occur, and so that sidewalks, driveways, roads and berms may be placed or replaced shortly after completion of backfilling.
- C. The Contractor will be held to have compared the conditions of the site where work is to be performed with the drawings and specifications and to have satisfied himself as to the conditions of the site, existing conditions, and any other conditions affecting the carrying out of the work, before delivery of his proposal. It is expressly understood that he will obtain first hand information concerning the available facilities for receiving, transporting, handling and storing construction equipment and materials and concerning other local conditions that may affect his work.
- D. The Contractor shall draw his own conclusions as to soil and/or rock conditions to be encountered, and he shall complete the work under any job or field condition which was present and/or ascertainable prior to bidding.
- E. He shall also complete the work under whatever conditions he may create by his own sequence of construction, construction methods, or other condition he may create at no additional cost to the Owner.
- F. The Contractor shall be responsible for evaluating the compatibility of his construction methods with the Plans, Specifications and Soil Information provided by the Owner for bidding purposes.
- G. No allowance or extra consideration on behalf of the Contractor will subsequently be allowed by reason of error or oversight on the part of the Contractor.
- H. This contractor shall grade all areas within his work area and provide slopes, shoulders, berms, and level surfaces defined according to existing and established grades.
- I. Care shall be taken to retain, at all times, normal flow of drainage water on the property and all present above ground and underground utilities.
- J. All work shall be done in a thorough and workmanlike manner and in conformance with accepted good practices and all requirements of local, state, and federal authorities having jurisdiction.

1.4 REGULATORY REQUIREMENTS

- A. Conform to applicable state and local codes for disposal of excavated materials judged not suitable for backfill.
- B. Obtain disposal permit from Local Enforcing Agency.

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1.5 QUALITY ASSURANCE

- A. Comply with all code, laws, ordinances, and regulations of governmental authorities having jurisdiction over this part of the work.
- B. Backfill materials shall be compacted to not less than specified percentage of optimum dry density as determined by ASTM D 698.
- C. Testing of backfill material will be done in accordance with ASTM D 2922, ASTM D 1556, and ASTM D 3017.
- D. Unsuitably compacted backfill materials shall be removed and recompact.

1.6 SITE CONDITIONS

- A. Provide and maintain barricades, warning lights, warning signs, and other protection required by applicable laws for safety of persons and property.
- B. Protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent earth movement.
- C. Notify Owner of unexpected subsurface conditions and discontinue affected work area until notified to resume work.

1.7 HAZARDOUS/CONTAMINATED MATERIAL

- A. The following indicators shall be used by Owner onsite observers during excavation to identify materials suspected of being hazardous or contaminated and requiring disposal in a Type I or Type II landfill.
 - 1. Materials other than general construction debris of a color not consistent with the natural soils observed in the area;
 - 2. Materials other than general construction debris of a consistency that is not consistent with the natural soils observed in the area;
 - 3. Man-made containers, vessels, tanks, or barrels;
 - 4. Electric devices;
 - 5. Insulation or fibrous material that may contain asbestos;
 - 6. Material that emits a chemical or petroleum odor.

Based on these observations, materials in question shall be stockpiled separately, inspected, and representative samples should be collected and screened in the field. Materials should be stored on plastic sheeting at the predesignated, secure location on the parcel or an adjacent parcel and covered with plastic sheeting until disposal is determined.

- B. Potentially hazardous materials should be screened in the field by qualified personnel for the presence of volatile organic compounds (VOC) using a photoionization (PI) meter. It is assumed that the presence of VOCs should provide a general indicator of the presence of other potentially hazardous chemicals.

Materials to be subjected to further laboratory analysis should be selected based on the results of the field screening and observations made by the person monitoring the excavation.

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- C. Based on the field screening and laboratory analysis, the Contractor will be advised by the Owner as to the required method of disposal.
- D. The Owner will be responsible for testing of hazardous/contaminated material.
- E. Refer to Specification 000_ITB – Instructions to Bidders for additional requirements.

PART 2 PRODUCTS

2.1 BACKFILL

- A. All material necessary to complete the backfill as shown on the drawings or to replace excavated unsuitable material shall be furnished by the Contractor. Backfill at the structures, unless otherwise indicated on the Drawings, backfill replacing unsuitable material, backfill under gravel or stone and paved roads, shall all be granular material conforming to Michigan Department of Transportation (MDOT) Granular Materials Class II. If suitable material for backfilling is not available on site then suitable material shall be brought in from an off-site borrow pit by the Contractor at no additional cost to the Owner.
- B. The Owner shall have the right to reject any backfill material which when used in the work, does not accomplish the required compaction.
- C. All backfill material shall be free from large or frozen lumps, concrete rubble, blue clay, sod, wood, debris, and other extraneous material.

2.2 ENGINEERED FILL

- A. All material necessary to complete the backfill as shown on the drawings or to replace excavated unsuitable material shall be furnished by the Contractor. Engineered Fill at the structures, unless otherwise indicated on the Drawings, backfill replacing unsuitable material, backfill under gravel or stone and paved roads, shall all be granular material conforming to Michigan Department of Transportation (MDOT) Granular Materials Class II. If suitable material for backfilling is not available on site then suitable material shall be brought in from an offsite borrow pit by the Contractor at no additional cost to the Owner.
- B. The Owner shall have the right to reject any backfill material which when used in the work, does not accomplish the required compaction.
- C. All backfill material shall be free from large or frozen lumps, concrete rubble, blue clay, sod, wood, debris, and other extraneous material.
- D. Engineered Fill shall be compacted to 95% Modified Proctor (ASTM

2.3 FLOWABLE FILL

- A. Where called for on the Drawings certain areas of the excavation and areas of existing structures shall be backfilled with flowable fill.

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- B. Flowable fill shall consist of a mixture of fly ash, cement and water such as "CFill" as manufactured by Clawson Concrete or "MCrete" as manufactured by Michigan Foundation or equal.
- C. Cement shall be Portland Cement conforming to A.S.T.M. C 150 Type I. Air entrained cement, pozzolan, and other types of cement shall not be used. Fly ash shall conform to the requirements of A.S.T.M. C618, Class F. Water shall be potable.
- D. The stabilized fly ash mixture shall contain 4 to 5% Portland cement based on the dry weight of the fly ash. Occasional batches of mixture with a cement content of 34% will be allowed provided immediate action is taken to restore the cement content to the specified range. Mixtures containing less than 3% shall not be used. The mixture shall have a slump of 10 to 12 inches at the point of placement. The mix temperature shall not be lower than 50°. The mixture shall have a compressive strength of 150 psi minimum at 28 days.
- E. The method used to measure fly ash and cement shall be submitted for acceptance. The contractor's proposed method shall be one that compliments the type of mixing plant being used and provides assurance that the percentage of cement is being satisfactorily controlled. Cement content shall be based on the dry weight of the fly ash in the mix. The batched weight of fly ash shall be corrected for its moisture content. Water shall be measured, although its control will be a function of consistency (slump and workability) of the mix.
- F. The flowable fill may be mixed by a pug mill, central concrete mixer, turbine mixer or other acceptable equipment or method. Provisions shall be made to maintain the mix temperatures and slump as stated.
- G. The material shall be placed by end or side dumping, tremie, pump, conveyors, or other suitable method. Lines and grades shall be as shown on the design drawings. Stabilized fly ash shall be protected from freezing temperatures for the initial 24 hours after placement. Protection may consist of earth cover, straw, or a sacrificial layer of the stabilized fly ash mix.

PART 3 EXECUTION

3.1 EXCAVATIONS

- A. The Contractor shall make all excavation necessary for the construction of all work called for by the drawings or specified herein.
- B. Excavations shall be made to the line and grade shown on the drawings including removal of unsuitable soils from under structures or roads, or as required to meet MIOSHA regulations. Side slopes of unbraced excavations shall be such as to prevent slides which might injure the work. The Contractor shall conduct his excavation and other operations in such a manner as to ensure that the bed for footings and foundations remains free from rutting, trampling, or other undue disturbance. The beds for footings and foundations shall be true to grade and free of all loose material before any concrete is put in place. All unauthorized excavation below grade of any structure shall be backfilled with concrete to the proper grade at the Contractor's expense. The Contractor shall make all necessary fills to bring grade to finished grade shown on the drawings. Fills and cuts shall be graded to a uniform, smooth, and even grade to grades as shown on the Drawings to meet Owner's approval. Existing underground utilities that are

to remain in place shall be protected and any damage caused by excavating shall be made good.

- C. Control the grading in the vicinity of excavated areas so that the surface of the ground will be properly sloped to prevent water from running into the excavated areas. Such areas shall be kept reasonably dry at all times. Accumulated water in the excavated areas shall be removed by pumping.
- D. Broken concrete or rubbish unsuitable for backfill shall be disposed of by the Contractor. Borrow material shall be graded in such a way that surface water will continue to drain in a manner similar to the drainage patterns present before filling occurred. Broken concrete and rubbish shall be disposed of off-site.

3.2 UNAUTHORIZED EXCAVATIONS

- A. Whenever the excavation is carried beyond the lines and grades established by the drawings or as approved by the Owner, the Contractor shall, at his own expense, fill all such excavated space with an approved material and in such a manner as to meet the approval of the Owner.
- B. Unauthorized excavation beneath structures shall be filled with plain concrete, or flowable fill as determined by the Owner.

3.3 SUBGRADE

- A. The subgrade for all structures shall be prepared so as to have as near as practicable a uniform density throughout the entire area. The subgrade shall be compacted to 95% maximum density at optimum moisture content as specified in AASHTO-180 or by Michigan Cone density, whichever is greater, by rolling or by other approved methods. After being prepared, the subgrade shall be maintained until concrete has been placed thereon.
- B. If, through neglect or delay on the part of the Contractor, the earth at subgrade elevation becomes unsuitable for the support of the work to be constructed thereon, the Contractor shall excavate down to solid earth, and shall backfill to the required subgrade elevation with plain concrete, compacted sand, or other suitable material as required to meet the Owner's approval. Unstable subgrade soil under all concrete foundations shall be replaced with plain concrete.
- C. All subgrades shall be approved by the Engineer before proceeding with backfilling and compaction, landscaping, or other construction work.
- D. Subgrades shall be level and clean of all loose rock, dirt, and debris and free of standing water prior to placing concrete.

3.4 SLOPES, AND BRACING

- A. All slopes shall be cut and maintained to the proper degree required for stability. Bracing shall be placed and maintained as indicated and/or whenever required for safety to men and the work. The degree of slope for all excavations shall be fixed by the Contractor, and shall comply with all State and Federal safety requirements.

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- B. The Contractor shall provide, install, and maintain all shoring, and bracing required to maintain banks of excavations and other construction, and assume full responsibility for same. The design of all shoring systems shall be performed by an Engineer registered in the State of Michigan utilizing loading diagrams as provided in Section 1900 of the Specifications. The shoring system design computations shall be sealed by the Engineer who prepared them and forwarded to the Owner for review. Refer to the Drawings for additional requirements.
- C. Bracing and timbering shall be so placed as to allow the work to be constructed to the lines and grades shown on the drawings.
- Size and placing of members shall be subject to review by the Owner but the design of members and safety of the excavation shall be the responsibility of the Contractor.
- Exact areas to be braced excavated and final weight of braced excavation shall be determined by the Contractor unless otherwise indicated for permanent braced excavation. Actual quantity and location of all braced excavation required for this project shall be determined by the Contractor.
- D. Piling shall be driven to depths and lengths required by the Contractor unless otherwise indicated for permanent braced excavation. Level measurements, utilizing previously specified bench marks, shall also be made at existing structures, in the presence of the Owner's designated representative, during all driving of piling to record any change in the level of present structures or utilities caused by the Contractor's Operations.
- E. Permanent piling where indicated on the drawings shall be of weight, area and depth shown on the drawings and shall remain in place.
- F. Temporary braced excavation may not be withdrawn from any area until concrete within the zone influenced by vibrations set up by withdrawal operations, has attained its 28-day design strength.
- G. If the braced excavation cannot be removed without detriment to the finished structure or existing structures, then the braced excavation shall be left in place temporarily or permanently as the Owner shall approve. Braced excavation left in place permanently shall be cut off at the required level so as not to interfere with subsequent construction. The cost of materials left in place less the eliminated expense of removal work shall be paid as an extra. No extra payment shall be allowed for the cost of placing the material.
- H. All bracing used shall be so arranged as to place no stress on any portion of the completed work until such work shall have developed sufficient strength, as determined by the Owner. Any damage to any structures occurring through settlements, water or earth pressure, slides, caveins, or other causes shall be repaired by the Contractor at his own expense.
- All materials used for earth bracing or support shall be structurally sound, uniform in quality, and adequate in size and strength for the use intended.

3.5 BACKFILL AND COMPACTION

- A. It is the intent of these Specifications that backfill shall be so placed and consolidated that no appreciable subsequent settlement will occur.

- B. Backfill shall be placed in uniform layers not exceeding 12 inches in depth when measured loose and each layer shall be thoroughly compacted by tamping, sheepsfootroller, mechanical vibrators, or by other effective means approved by the Owner. All backfill in all areas shall be compacted to at least 95% of maximum density, at optimum moisture content as specified in MDOT Standard Specifications for Construction Controlled Density Method. Compaction by flooding will not be permitted.
- C. Engineered Fill shall be placed in uniform layers not exceeding 9 inches in depth when measured loose and each layer shall be thoroughly compacted by tamping, sheeps footroller, mechanical vibrators, or by other effective means approved by the Owner. All Engineered Fill in all areas shall be compacted to at least 95% of maximum density, at optimum moisture content as specified in MDOT Standard Specifications for Construction Controlled Density Method, unless otherwise noted on the Drawings. Compaction by flooding will not be permitted.

The Owner shall have the right to reject any backfill material which when used in the work, does not accomplish the required compaction.
- D. The Contractor shall furnish all necessary assistance and test pits as required for the Owner to conduct compaction density tests.
- E. No backfill material shall be placed on areas where free water is standing or on frozen subsoil areas.
- F. Clean areas and excavations to be backfilled of all trash and debris before placement of backfill. In placing backfill, take special care to prevent any wedge action, eccentric loading, damage, or overloading of any adjacent structures, piping, and equipment by equipment used in compacting backfill material.
- G. Heavy equipment for spreading and compacting fill and backfill shall not be operated closer to a wall than a distance equal to the height of the fill or backfill to be placed. Power-driven hand operated equipment shall be used against walls and where space limits the use of heavy equipment.
- H. All excavations around the walls and other foundations, etc., shall be backfilled to meet Owner approval after all work has been inspected and approved. Backfill shall not be placed against walls until all supporting slabs are in place and have attained their design strength or as indicated on the structural drawings.
- I. If compaction tests indicate work does not meet specified requirements, remove work, replace and retest at no cost to the Owner.
- J. Porous stone filters shall be furnished and installed where shown on the Drawings. Stone filters shall be encased in a drainage geotextile fabric as specified in Section 02220 of these specifications.

3.6 FINISH GRADING

- A. The Contractor shall grade the entire site as indicated on the drawings to a smooth and even grade, meeting existing grades and/or the grades indicated on the drawings.

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- B. Excavated material suitable and approved for backfilling shall be stored on the site in areas approved by the Owner. Reusable topsoil that is displaced shall also be stored on the site in separate area from the backfill.
- C. Finish grade under gravel road areas and under paved areas shall be limited to 1/2 inch in 10 feet from true profile, and shall be maintained until succeeding layer or surface course is placed.
- D. Finish grading shall slope uniformly to contour lines shown on the Drawings, and to meet existing adjacent levels. The Contractor shall grade all areas within his work site and provide slopes, shoulders, berms, and level surfaces defined according to existing and established grades. The work shall also include all adjacent areas disturbed by construction and as required by new pavement installation.
- E. The subgrade for all slabs and pavements shall be prepared so as to have as near as practicable a uniform density throughout the entire area. The subgrade shall be compacted to 95% maximum density at optimum moisture content, as specified under BACKFILL AND COMPACTION herein, by rolling or by other approved methods. After being prepared, the subgrade shall be maintained until concrete or pavement has been placed thereon.
- F. If, through neglect or delay on the part of the Contractor, the earth at subgrade elevation becomes unsuitable for the support of the work to be constructed thereon, the Contractor shall excavate down to solid earth, and shall backfill to the required subgrade elevation with plain concrete, or other suitable material as required to meet the Owner's approval.

Soil found to be unstable in the subgrade shall, when required to meet the Owner's approval, be excavated to firm soil and replaced with MDOT Granular Material, Class II, as specified above thoroughly compacted. Subgrade area supporting structures shall have unstable material replaced with Owner approved concrete.
- G. Refer to Section 02930 - General Landscaping Materials and Final Grading for Site.

3.7 INSTALLATION OF PERIMETER DRAINS

- A. Install at locations where drains are shown on Contract Drawings.
- B. Install aggregate and filter cloth as shown on details on Contract Drawings.
- C. Compact aggregate as specified and complete filter cloth installation prior to completion of backfill.

END OF SECTION

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SECTION 02201

MONITORING VIBRATIONS

a. Description

This work shall consist of furnishing all the necessary labor, materials, and equipment to monitor vibrations at the Headworks Building during construction of the Influent Building, including associated piping and services, and to assure that vibrations are within the tolerances set forth in this Section. Construction activities include, but are not limited to, the installation of sheeting and the demolition of existing portions of the Headworks Building structure. The existing structures adjacent to the proposed construction, which are designated to remain, shall not be damaged throughout the project. The contractor is referred to AASHTO Designation: R 8-96 "Standard Recommended Practice for Evaluation of Transportation-Related Earthborne Vibrations" for guidance in addition to this Section.

b. Vibration Monitoring

The Contractor shall retain the services of a vibration consulting firm with personnel to conduct the following vibration monitoring requirements:

1. Submitting of monitoring plans and daily reports, overseeing installation of the vibration monitoring equipment and interpretation of vibration monitoring data shall be performed by personnel with the following qualifications:
 - A. Must be a Professional Engineer currently registered in the State of Michigan.
 - B. Must have a minimum of five years' experience in the vibration consulting field.
 - C. Must have successfully completed at least five projects that involved monitoring vibrations and evaluating effects of vibrations on structures.
2. Installation and monitoring of the vibration monitoring equipment, and collection of the vibration monitoring data shall be performed by personnel with the following qualifications.
 - A. Must have at least three years of experience in the operation of the proposed monitoring equipment and interpretation of data produced by such equipment.
 - B. Must have installed, operated, monitored, and interpreted vibration monitoring equipment and data on at least five projects that involved monitoring vibrations and evaluating the effects on structures.

The qualifications shall be submitted to the Engineer for review and approval at least one week prior to the start of monitoring.

c. Survey/Structure Monitoring Points

Engage a Land Surveyor or Professional Engineer currently licensed in the State of Michigan to survey adjacent existing buildings, structures, and site improvements, establishing exact elevations at fixed points to act as Structure Monitoring Points (SMP). Clearly identify SMPs and record existing elevations before any vibration producing construction operations commence.

1. During construction and dewatering, regularly resurvey SMPs, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Engineer if changes in elevations occur or if cracks, sags, or other damage is evident in the adjacent structures.

d. Construction

The Contractor's vibration consultant shall develop a detailed vibration and SMP monitoring program, install all the necessary vibration monitoring equipment, monitor vibrations and SMPs during vibration-inducing operations, and interpret vibration monitoring data throughout construction. The vibration consultant's monitoring program shall be submitted to the Engineer for approval one week prior to the start of construction. The following items must be met:

1. The consultant's monitoring plan shall be developed in accordance with AASHTO R 8-96. The instrumentation locations, monitoring procedures, and a description of the monitoring devices and/or the manufacturer's brochures shall be included in the submitted plan. The monitoring plan should also include the locations and numbering system for the proposed SMPs defined above. The Plan should include a minimum of two (2) vibration monitoring locations and ten (10) SMPs.
 2. The record peak particle velocity (PPV) at the ground surface along a direct line to the nearest adjacent structures should not exceed 0.50 inch/sec. Any records in excess of this particle velocity shall require immediate cessation of the construction activities that are responsible for the excess ground vibration.
 3. All SMPs should be surveyed and recorded on a weekly basis during vibration activities. Settlement shall not exceed 0.5 inch over the course of the project. Green conditions are maintained when settlement is less than 0.25 inch and weekly recordings should continue. Yellow conditions are considered when recorded settlements are greater than 0.25 inch but less than 0.5 inch. Under Yellow conditions, the Contractor shall notify the Engineer and survey frequency at all SMPs should be increased to daily and field data reported to the Engineer within 24 hours of recordings. When SMP data exceeds 0.5 inch, all construction activities shall cease, and the Contractor shall submit a contingency plan for structure stabilization for Engineer Approval.
 4. Should records of peak particle velocity or settlement of SMPs exceed the limits set forth above, construction activities shall cease and:
 - A. The Engineer shall be notified immediately.
 - B. A Corrective Action Plan (CAP) shall be submitted:
 1. The CAP shall be developed by the Contractor and shall identify any necessary changes in equipment or procedures associated with demolition of existing structures, installation of sheeting, material handling, storage, placement and compaction of embankment fills or backfills or any other construction activities producing excessive levels of ground vibration.
 2. Changes shall reduce construction vibrations to meet the limits set forth in this Section.
 3. The Contractor shall not be granted additional expenses or additional time for shut down associated with preparation of the CAP, including time required for review and approval of the CAP by the Engineer.
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4. The Contractor shall not be granted additional expenses associated with changes to means and methods as identified in the approved CAP, including changing equipment, materials, or means of demolition, installation, or construction. The Contractor cannot resume operations until the CAP is approved and the Contractor is instructed to do so by the Engineer.
5. Provide daily reports to the Engineer within 24 hours when vibration-inducing operations are taking place. The following shall be included:
 - A. The source of the vibration readings.
 - B. A plot of the ten highest readings (occurrences) on a graph of Particle Velocity (in/sec) vs. Frequency (Hz). Include the U.S. Bureau of Mines (USBM) RI 8507 curve on the same graph.
 - C. Instances, dates, and times when recordings exceeded the threshold limits.
 - D. On a weekly basis, provide a summary report of the vibration data recorded with commentary regarding the activities, recorded data, along with comparison to the allowable vibration limits defined above.
 - E. On a weekly basis, provide a summary report of the SMP data collected with commentary regarding recorded events versus allowable limits. Plot an ongoing graph with settlement versus time graphically showing the settlement progression for all SMP locations.
 - F. At the end of the vibration inducing portion of the project, produce a Log PPV vs. Log Distance Plot based upon all the data collected and estimate the distance from the vibration source where PPV exceeds 0.5 in/sec.

The Contractor shall protect all vibration monitoring equipment and SMPs for the duration of the project. The Contractor shall have complete responsibility for the monitoring and control of vibrations, prevention of consequent settlement and/or damage to the existing structures adjacent to the project site and for repair of any damage whatsoever resulting from operations. Repairs due to damage shall be at the Contractor's expense.

END OF SECTION

SECTION 02202

DRAINAGE GEOTEXTILES

PART 1 GENERAL

1.1 RELATED SECTIONS

- A. Section 02200 –Earthwork

1.2 REGULATORY REQUIREMENTS

- A. Conform to ASTM D4759

PART 2 PRODUCTS

2.1 DESCRIPTION

- A. This work shall consist of furnishing and placing a geotextile for drainage applications as shown on the drawings. The geotextile shall be designed to allow passage of water while retaining insitu soil without clogging. The quantities of drainage geotextiles as shown on the plans may be increased or decreased at the direction of the Engineer based on construction procedures and actual site conditions that occur during construction of the project. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

2.2 MATERIALS

- A. Fibers used in the manufacture of geotextiles, and the threads used in joining geotextiles by sewing, shall consist of long chain synthetic polymers composed of at least 85% by weight polyolefins, polyesters, or polyamides. They shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including selvages. These materials shall conform to the physical requirements of Table 1.
- B. Geotextile rolls shall be furnished with suitable wrapping for protection against moisture and extended ultraviolet exposure prior to placement. Each roll shall be labeled or tagged to provide product identification sufficient for inventory and quality control purposes. Rolls shall be stored in a manner which protects them from the elements. If stored outdoors, they shall be elevated and protected with a waterproof cover.

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2.3 TABLE 1 – PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILES

<u>PROPERTY</u>	<u>CLASS A4</u>	<u>CLASS B5</u>	<u>TEST METHOD</u>
Grab Strength Lbs.	180	80	ASTM D 4632
Elongation (%)	N/A	N/A	ASTM D 4632
Sewn Seam Strength ⁶ Lbs.	160	70	ASTM D 4632
Puncture Strength Lbs.	80	25	ASTM D 4833
Burst Strength psi	290	130	ASTM D 3786
Trapezoid Tear Lbs.	50	25	ASTM D 4533
Apparent Opening Size	1. Soil with 50% or less particles by weight passing U.S. No. 200 Sieve, AOS less than 0.6mm (greater than #30 U.S. Std. Sieve) 2. Soil with more than 50% particles by weight passing U.S. No. 200 Sieve, AOS less than 0.297mm (greater than #50 U.S. Std. Sieve).		ASTM D 4751
Permeability (cm/sec)	k fabric >k soil for all classes		ASTM D 4491
Ultraviolet Degradation at 150 Hours	70% Strength retained for all classes		ASTM D 4355

1. Acceptance of geotextile material shall be based on ASTM D 4759.
2. Contracting agency may require a letter from the supplier certifying that its geotextile meets specification requirements.
3. Minimum - use value in weaker principal direction. All numerical values represent minimum average roll value (i.e., test results from any sampled roll in a lot shall meet or exceed the minimum values in the Table). Stated values are for non-critical, non-severe applications. Lots samples according to ASTM D 4354.
4. Class A Drainage applications for fabrics are where installation stresses are more severe than Class B applications; i.e., very coarse, sharp angular aggregate is used, a heavy degree of compaction (95% AASHTO T99) is specified or depth of trench is greater than 10 feet.
5. Class B Drainage applications are those where fabric is used with smooth graded surfaces having no sharp angular projections, no sharp angular aggregate is used;

compaction requirements are light (<95% AASHTO T99) and trenches are less than 10 feet in depth.

6. Values apply to both field and manufactured seams.
7. A nominal coefficient of permeability may be determined by multiplying permittivity value by nominal thickness. The k value of the fabric should be greater than the k value of the soil.

PART 3 EXECUTION

3.1 CONSTRUCTION REQUIREMENTS

- A. Geotextile Exposure Following Placement: Exposure of geotextiles to the elements between laydown and cover shall be a maximum of fourteen (14) days to minimize damage potential.
- B. Geotextile Placement: Successive sheets of geotextiles shall be overlapped a minimum of 12 inches in the direction of flow.
- C. Seams: Where seams are required in the longitudinal trench direction, they shall be joined by either sewing or overlapping. All seams shall be subject to the approval of the Engineer.
- D. Overlapped seams shall have a minimum overlap equal to the width of the trench.
- E. Repair: A geotextile patch shall be placed over the damaged area and extend three (3) feet beyond the perimeter of the tear or damage.

END OF SECTION

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SECTION 02214

ROADWAY EXCAVATION, BACKFILL, AND COMPACTION

PART 1 GENERAL

1.1 DESCRIPTION

- A. General excavation, backfill, and compaction are specified under Section 02200. This specification details additional requirements for roadway excavation, backfill, and compaction.
- B. Related Work Specified Elsewhere:
 - 1. Section 01900 - Soil Conditions and Boring Logs.
 - 2. Section 02140 - Dewatering.
 - 3. Section 02511 - Hot Plant Mixed Bituminous Pavement.

1.2 SUBMITTALS

- A. Source of Materials: Submit the source of fill and granular materials proposed for the work, giving location, and as applicable, name and address of supplier.
- B. Samples: Submit samples of soil material proposed for fill or backfill to the testing laboratory services for soil classification tests.

1.3 JOB CONDITIONS

- A. Excess Water Control:
 - 1. Provide and maintain, at all times during construction, adequate means and devices which will promptly remove and dispose of all water from any source entering any area of the work.
 - 2. Dewater by means which will ensure dry work areas and preservation of the final lines and grades.
 - 3. Provide berms or channels to prevent flooding of subgrade. Promptly remove all water collecting in depressions.
 - 4. If soil becomes softened or eroded by flooding, remove all damaged areas and recompact as specified under "Preparation of Roadway Subgrade."
- B. Environmental Requirements:
 - 1. Do not place, spread, or compact any fill or subbase materials during unfavorable weather conditions.
 - 2. Do not resume operations until moisture content and densities of fill and subbase materials are satisfactory to the Engineer.
- C. Protection:
 - 1. Provide and maintain barricades, warning signs, warning lights, and other protection required by applicable laws, regulations and safety codes for safety of persons and

protection of property during roadway excavation, backfill, and compaction operations.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Class 2 Granular Material:
 - 1. Approved sand, gravel, crushed stone, blast-furnace slag or combination thereof, with 100 percent passing 3-inch sieve, 60 to 100 percent passing 1-inch sieve, 0 to 30 percent passing No. 100 sieve, and loss by washing not to exceed seven percent.
 - 2. MDOT Standard Specifications 8.02.06 Granular Material Class II.

2.2 EQUIPMENT

- A. Excavation, aggregate spreading and compaction equipment shall be of type necessary to achieve the indicated and specified results.

PART 3 EXECUTION

3.1 INSPECTION

- A. Site Conditions: Prior to start of work under this Section, become thoroughly familiar with site conditions to verify that all work under this Section may be properly completed as specified.

3.2 EXCAVATION

- A. Excavation shall include removal, hauling, and disposal of all classes of materials and obstructions encountered while excavating of whatever nature and in whatever state.
- B. Excavate all materials necessary for construction of a prepared roadway subgrade to the elevations and cross-sections indicated on the Drawings.
- C. Excavation shall at all times be performed in a manner and sequence that will provide drainage.
- D. Excavated material meeting requirements specified for Fill Material may be used to construct embankments and fills.
- E. Excavated material unsuitable for reuse shall be disposed of by the Contractor offsite.
- F. Excess excavated material suitable for fill shall be disposed of and any shortage shall be made up with approved borrow.
- G. Preparation of roadway subgrade:
 - 1. All areas shall be compacted to not less than 95 percent of maximum density as determined by the Modified Proctor Test method unless otherwise specified.

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2. Any material within lines two feet outside the proposed surfacing that cannot be compacted to 95 percent of maximum density as determined by the Modified Proctor Test method shall be removed.
3. After removal of unsuitable material, where possible, 6 inch perforated clay drainage tile shall be placed from the low point of excavated area to a natural drainage course, ditch or storm sewer structure. The excavated area shall then be backfilled with an approved porous material.
4. Where an outlet for drainage tile is not available and the surrounding earth is impervious, the backfill shall be made with clay free from silt and topsoil.

3.3 EMBANKMENTS AND FILLS

- A. Filling: After subgrade compaction has been approved by the Engineer, Fill Material or Class 2 Granular Material shall be spread in layers not to exceed six inches for clay and 12 inches for sand. When embankments are to be constructed on existing slopes steeper than one vertical to six horizontal, steps shall be formed in the slope before fill is placed.
- B. Embankments shall not be constructed on frozen earth, ice, snow, topsoil, muck or other unstable material.
- C. Moisture Conditioning: Water or aerate the material as necessary and thoroughly mix to obtain a moisture content which will permit proper compaction.
- D. Compaction: Each layer of embankment and fill material shall be compacted to 95 percent of maximum density as determined by the Modified Proctor Test.

3.4 CLEANING

- A. Make every effort to keep roadways free from waste material resulting from earthwork operations. Clean such surfaces as required, or when directed, to eliminate any waste material deposited.

END OF SECTION

SECTION 02220

SOIL EROSION CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This specification section provides certain requirements, techniques and measures to minimize erosion damage to the construction site.

1.2 GENERAL

- A. In general, the Contractor shall conduct his operations in such a manner as to limit any exposed area of any disturbed land for the shortest practicable period of time and any sediment caused by soil erosion due to his operations shall be restricted and reduced to a non-polluting minimum before it leaves the site.
- B. The Contractor shall comply with all requirements under the Soil Erosion and Sedimentation Control Act, 1972 Public Act 347. Where these specifications are more stringent than Act 347 then these specifications shall govern.
- C. All temporary stabilization work done shall be coordinated with Section 02930 – General Landscape Materials and Final Grading for site so that this work does not interfere with the final site restoration.

1.3 RELATED SECTIONS

- A. Section 02110 - Site Clearing
- B. Section 02200 – Earthwork
- C. Section 02930 - General Landscape Materials and Final Grading
- D. Section 02990 - Permits

1.4 INLAND LAKES AND STREAMS ACT

- A. All waterway crossings are subject to the provisions of the Inland Lakes and Streams Act, 1972 Public Act 346, as amended and Administrative Rules. The Contractor shall obtain the latest version of these regulations for use on this project as reference material. Special attention is directed to applicable portions of Rules 22 through 29, inclusive. The Contractor's activities shall adhere to the provisions of this act and the Contractor shall hold the Owner harmless from any violations, civil action or penalties arising from the Contractor's actions.

1.5 BASIS OF PAYMENT

- A. All costs associated with the above stated requirements shall be considered incidental to the project and shall be included in the bid.

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- B. The Owner shall obtain the necessary Soil Erosion and Sedimentation Control Permit and the Wetlands Permit from the State of Michigan with no cost to the Contractor.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Refer to the following Table 1 for stabilization materials and seasons for use. Also, coordinate this work with Section 02930 – General Landscape Materials and Final Grading so that any soil stabilization done does not interfere with the final site restoration.

TABLE I
MATERIALS FOR STABILIZATION
OF CONSTRUCTION AREAS

<u>Material</u>	<u>Amount</u>	<u>Season</u>
Spring Oats or Barley or Domestic Rye Grass or Sudan Grass or Rye or Perennial Ryegrass or Wheat	25 lbs/acre 35 lbs/acre 25 lbs/acre 25 lbs/acre 2.5 bus/acre	April 1 to Aug. 15 June & July Aug. 1 to Oct. 15 Sep. 20 to Oct. 15
Fertilizer: 12-12-12 Commercial	600 lbs/acre	Seeding Season
Mulch: Sm. grain Straw Hay	2 tons/acre	All Year
Spray Coating: Liquid Asphalt RC 1, 2, or 3 MC 2 or 3	0.10 gal/s.y.	All Year
Asphalt Emulsion: RC 1 or 2 MC 2	0.04 gal/s.y.	Spring & Fall

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<u>Material</u>	<u>Amount</u>	<u>Season</u>
Mulch: Kraft Paper	Cover Area	All Year
Netting:	See Mulching Section	
Top Soil for Permanent Seed:	3"	Seeding Season
Top Soil for Sod:	3"	Sodding Season
Sod: MDOT 8.21 Class B	1-1/2" x 10" x 18" min.	May 1 to Oct. 20
Pegs: Sound Wood	8" long (min.) 0.75 sq. in. (min.)	

PART 3 EXECUTION

3.1 EROSION PROTECTION-CROSSING DRAINS/STREAMS

- A. In order to limit the length of time that the exposed area is subject to the elements and the subsequent conditions causing erosion, the contractor shall adhere to the following requirements.
1. The banks of drains will not be left unprotected for more than one day where possible, but never more than seven days. Construction will not be allowed to continue at the expense of not providing stream bank protection. All spoils including organic and inorganic soils, vegetation and debris shall be placed above the ordinary high water mark, leveled and stabilized with sod and/or seed, fertilized and mulched, in such a manner as not to erode into any waterbody or wetland.
 2. All disturbed drain banks will be finished with a slope not steeper than 2:1 (2 horizontal to 1 vertical) and in accordance with grading plans. Fill shall consist of inert materials which will not cause siltation nor contain soluble chemicals or organic matter which is biodegradable. All fill shall be contained in such a manner as not to erode into any watercourse. All raw banks shall be stabilized with sod, seed, fertilizer and mulch or riprapped as necessary to prevent erosion.
 3. All raw soil will be either sodded or seeded, fertilized and mulched. On slopes greater than 10 percent, sod will be pegged for stability.
 4. Deflection dikes consisting of gravel or other suitable material, reinforced by one row of sandbags, will be used to divert runoff from steep slopes adjacent to water courses, where contributing runoff could be great enough to cause slope erosion and resulting sedimentation at the ditch. Diversion berms, filter berms, diversion ditches or terracing may be appropriate.
 5. Excavation shall stop some distance from ditches to leave a protective plug of 10 to 20 feet of unexcavated material at each bank. These plugs shall be left in place.

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- B. Any unforeseen situations that may be encountered during the course of construction, that may cause accelerated erosion and deposition of sediment into waterways and/or lakes, will be controlled by methods that may include sediment traps, sediment basins, or holding ponds. Any slope failures or development of gullies after construction has been completed will be corrected immediately.

3.2 EROSION PROTECTION-OPEN CUT CONSTRUCTION

- A. In order to limit the length of time that the exposed area is subject to the elements and subsequent conditions causing erosion, the Contractor shall adhere to the following requirements.
 - 1. Burlap Silt Traps (or equivalent) shall be placed between the frame and cover of all manholes, catch basins, and gate wells in the construction area. The burlap shall be periodically replaced if silt buildup causes the trap to function improperly.
 - 2. Underground piping and conduit construction, including installation of pipe, backfilling, surface restoration and removal of excess excavation shall be accomplished in one continuous operation. Backfilling, removal of excess excavated material and final or temporary stabilization (according to seasonal limitation) shall follow pipe laying and conduit construction by no more than 100 feet.
 - 3. Excess excavated materials shall be removed from the job site. Excess excavated material shall be disposed of in accordance with Section 02200-Earthwork. A soil erosion plan must be prepared by the Contractor for each fill area and it shall be approved by a proper authorized agency and implemented before starting filling operations.

3.3 APPLICATION OF PERMANENT STABILIZATION

- A. Permanent stabilization shall be applied to all areas disturbed by the Contractor during completion of the work required by the Contract.
- B. The stabilization shall be accomplished within 7 days of completion of the final earth change provided that change is made within the stated season for such stabilization.
- C. If the final earth change is accomplished at a time outside of the stated seeding or sodding season, temporary stabilization shall be applied within 7 days of completion of the final earth change and shall be replaced with permanent stabilization as soon after the following April 20 as the ground is workable.

3.4 APPLICATION OF TEMPORARY STABILIZATION

- A. Temporary stabilization shall be applied to areas where initial work has caused disturbance and the final earth change will not be completed immediately and to areas where the final earth change is completed between October 1 and April 20.
- B. Temporary stabilization shall be applied to areas where the final earth change has been completed, including final grading and top soil placement, between the dates of October 1 and April 20. The disturbed areas shall have mulch placed and anchored as described in the following paragraphs. After April 20, areas to be seeded shall be seeded through the mulch. Mulch shall be added and anchored as necessary to replace that lost prior to April 20. Where

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sod is to be placed, the mulch will be removed or worked into the soil. If worked into the soil, the fertilizer application rate shall be increased by 25%.

- C. Areas disturbed by construction activities but on which the final earth change has not been made shall be graded to provide positive drainage and shall be stabilized to prevent erosion.
- D. Areas which receive an initial earth change during the period October 15 to April 1 and will not receive further work for any length of time within that season shall have mulch placed and anchored. If work is not anticipated in such areas prior to the following July 1, the area shall be seeded with temporary seeding on or shortly after April 1.
- E. Areas which receive an initial earth change between April 1 and October 15 and on which no further work is anticipated within 3 months shall receive temporary seeding and mulch.
- F. Areas which receive an initial earth change and on which further work is to be done within 3 months shall be graded to provide positive drainage and shall have mulch placed and anchored.

3.5 SEEDING FOR TEMPORARY AND PERMANENT STABILIZATION

- A. Site Preparation
 - 1. The seedbed immediately before seeding shall be firm but not so compact as to prohibit the seed from securing adequate germination or root penetration. Topsoil shall be replaced after grading operations for permanent stabilization. No topsoil is required for temporary stabilization. Tillage implements shall be used as necessary to provide at least a 3 inch depth of firm but friable soil, free of large clods and stones and other debris. All seeding shall be protected by mulching. See Sections 02200 and 02930 of these specifications for details of permanent stabilization which include spreading topsoil, seeding, fertilizing, mulching, establishment and guarantee. Mulching work shall also be included in temporary stabilization.
- B. Seeding Dates
 - 1. Seed shall be applied from April 20 to October 1 for permanent stabilization and from April 1 to October 15 for temporary stabilization and the seeded areas shall be kept moist for fourteen (14) days to insure growth. If the site is readied for seeding during non-seeding months, it shall be protected by mulching. The site can be seeded later through the mulch. Seeding shall not be done on frozen soil or if the soil is snow covered.
- C. Seedings
 - 1. Seed in a moist firm seedbed. Place seed from 1/4 to not over 1/2 inch in depth. See Table No. 1 for seeding mixture.
- D. Irrigation
 - 1. The Contractor shall apply water to the new seedings daily in order to insure that the seed bed is moist enough to allow germination and growth of the seeds.

3.6 SOD FOR PERMANENT STABILIZATION

- A. Site Preparation

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1. Fill areas must be compacted enough to resist uneven settling. Cut areas must be loosened if needed to permit grass root penetration. The entire surface to be sodded shall be free from large clods, stones, or other debris. Immediately before placing sod the soil surface shall be loosened to a depth of one inch and thoroughly dampened if not already moist.
 2. See Sections 02200 and 02930 of these specifications for sodding details which include type of sod, fertilizing, sod laying, establishment and guarantee.
- B. Sodding Dates
1. Sod shall be applied from May 1 until October 20 and properly irrigated. Frozen sod shall not be placed nor shall any sod be placed on frozen soil. During periods when sod cannot be laid, temporary stabilization methods shall be applied.
- C. Irrigation
1. The Contractor shall apply water to the new sod daily in order to insure that the sod is moist enough to allow growth.

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SECTION 02315

UTILITY TRENCHING, BACKFILL AND COMPACTION

PART 1 GENERAL

1.1 SUMMARY

- A. The work covered by this specification consists of furnishing all plant, labor, equipment, appliances and materials, and performing all operations in connection with the excavation and preparation of utility trenches and bedding and backfill of utilities to the locations, lines, elevations, and grades as provided for in the drawings, specifications, and special provisions of the Contract.
- B. Excavation, backfill, and compaction for appurtenant structures such as, but not limited to, manholes, inlets, catch basins, handholes, transitions sections, junction chambers, structures, vaults, valve boxes, gate wells, and hydrants, shall be deemed to be in the category of trench excavation.
- C. Protection of existing utilities, sidewalks, pavements, trees, and other facilities in the vicinity of the trench excavation is included in the work covered by this specification.
- D. Related Requirements
 - 1. Section 02669 – Buried Process Pipe and Fittings

1.2 MEASUREMENT AND PAYMENT

- A. Excavation and compaction for the preparation of a utility trench, including all the work as covered by this specification and any sheeting, shoring or bracing to safely install an underground utility, shall be included in the costs per unit of measurement for the associated utility to be installed.
- B. Excavation and compaction in preparation for the installation of an appurtenant structure as defined herein, including all the work as covered by this specification and any sheeting, shoring or bracing to safely install the appurtenant structure, shall be included in the costs per unit of measurement for the associated appurtenant structure to be installed.
- C. Bedding, Initial Backfill, and Final Backfill to final grade for the installation of a utility, including all the work as covered by this specification and all labor, materials, equipment and compaction necessary to successfully install an underground utility, shall be included in the costs per unit of measurement for the associated utility to be installed.
- D. Bedding, Initial Backfill, and Final Backfill for the installation of an appurtenant structure as defined herein, including all the work as covered by this specification and all labor, materials, equipment and compaction necessary to successfully install the appurtenant structure, shall be included in the costs per unit of measurement for the associated appurtenant structure to be installed.

- E. Protection of existing utilities, sidewalks, pavements, trees, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations shall be included in the costs per unit of measurement for the associated utility to be installed.
- F. Dewatering necessary to provide for a clean, dry trench free from standing water and so that there is no unbalanced upward pressure on the bottom of the open excavation until utility installation is completed shall be included in the costs per unit of measurement for the associated utility to be installed.

1.3 REFERENCES

- A. Abbreviations and Acronyms
 1. ASTM – American Society for Testing and Materials
 2. MDOT – Michigan Department of Transportation
 3. OSHA – Occupational Safety and Health Administration
 4. USCS – Unified Soil Classification System
- B. Definitions
 1. Appurtenant Structure – structures or appurtenances related to utility construction, such as but not limited to; manholes, inlets, catch basins, handholes, transitions sections, junction chambers, structures, vaults, valve boxes, gate wells, and hydrants
 2. Bedding – select granular material on which the utility is supported within trench excavations and installed at the trench subgrade elevation and up to a point within the pipe zone dependent on the pipe design, material and loading factors above and around the utility
 3. Final Backfill - area of the trench excavation cross-section extending from the top of the pipe zone to the top of the trench and bottom of the surface restoration or pavement section
 4. Haunch Bedding – area of the bedding cross-section between the bottom of the utility and the spring line of the utility
 5. Initial Backfill – area of the trench excavation cross-section extending from the top of the bedding material, to a minimum level of 12 inches over the top of the installed utility
 6. Initial Bedding Layer - area of the bedding cross-section between the subgrade and the bottom of the utility
 7. Inner Bedding – the bedding zone directly beneath the utility. Typically, the middle 1/3 of the trench bottom width
 8. Pipe Zone – area of the trench excavation cross-section extending from the subgrade to a level a minimum of 12 inches over the top of the installed utility
 9. Rock – All boulder, solid ledges, bedded deposits, unstratified masses, and conglomerations of material so firmly cemented as to possess the characteristics of solid rock that cannot be practically excavated with a track-mounted power excavator equivalent to a Caterpillar Model No. 325 or equivalent equipped with new rock teeth.
 10. Sand Backfill Trench – Utility trench or portion of utility trench or excavation in which the final backfill is within the zone of influence of existing or proposed graveled, slag or hard surfaced road, pavements, hard surfaced parking lots and driveways, sidewalks and curbs when the trench edge is within 3 feet of the edge of pavement or as specified.

11. Standard Backfill Trench – Utility trench or portion of utility trench or excavation outside the Sand Backfill Trench
12. Subgrade – Surface or elevation remaining after completing trench excavation or the top surface of an over-excavation or undercut backfill (stone or soil) immediately below the utility or utility bedding, as applicable. Commonly referred to as “Foundation”.
13. Suitable Material – Materials, either excavated or delivered, capable of meeting identified compaction requirements, meeting MDOT Class II, IIA, or IIIA or ASTM D 2487 soil classification group (USCS) SW, SM, SC, SP and or a combination of these group symbols; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
14. Unsuitable Material – Material which;
 - Contains rock, gravel or clay lumps larger than 3 inches in any dimension,
 - Contains more than 1% organic matter,
 - Has a Liquid Limit exceeding 40 and/or a Plastic Limit exceeding 10
 - Contains construction debris such as brick, broken concrete, wire, etc, or waste, vegetation, and other deleterious matter.
 - Is frozen or contains ice balls in excess of 3 inches in any dimension,
 - Maintains a moisture content, at the time of compaction, that exceeds the Optimum Moisture content, established by the method used to determine the Maximum Unit Weight, by three percentage points or more.
15. Utilities – Underground pipes, sewers, water mains, conduits, ducts, cables, as well as underground services to properties and buildings.
16. Zone of Influence - a one to one (1 horizontal to 1 vertical) slope from the edge of pavement to the trench bottom.

C. Reference Standards

1. ASTM D 2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
2. MDOT Density Testing and Inspection Manual
3. OSHA Standard 29 CFR Part 1926 – “Safety and Health Regulations for Construction”
4. Reference Standards that are cited specifically by name shall be the current versions of said manuals existing at the time of the award of the Contract.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Conform to applicable state and local codes for disposal of excavated materials judged unsuitable for backfill.
- B. Obtain disposal permit from the Local Enforcing Agency.
- C. Unless otherwise specified, provide third-party materials testing services for the testing requirements specified herein.
- D. Coordination
 1. The Owner is the sole operator of all water system valves and hydrants. Coordinate all utility service interruptions with Owner
 2. Contact the Owner to schedule field representation for construction observation.
 3. Coordinate with utilities for relocation, adjustment, or support of their facilities

E. Safety

1. Contractor is solely responsible for site safety.
2. Comply with applicable requirements of OSHA, specifically Standard 29 CFR Part 1926, Subpart P “Excavations”
3. Keep surface over and along trenches and other excavations in a safe and satisfactory condition during the process of the Work.

1.5 SUBMITTALS

- A. Pre-excavation photographs or other digitally recorded media to show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earthwork operations.
- B. Classifications and MDOT pit numbers of aggregates for Undercut Backfill, Bedding, Initial Backfill and Final Backfill and supporting material characteristic test results
- C. Supplier endorsements that certify materials meet project requirements.
- D. Sheeting, Shoring or Trench Box Construction Plan
- E. Dewatering Plan for utility trench, if necessary

1.6 QUALITY ASSURANCE

- A. Initial compaction tests will be made by a representative of the Owner and paid for by the Owner.
 1. If it is necessary to repeat compaction tests because initial compaction methods or construction procedures failed to produce required density, in place, the Contractor shall be billed for the cost of all repeat testing until material meets specifications
- B. Conduct a Pre-Excavation Meeting at the project site at the request of the Owner.
- C. Comply with all code, laws, ordinances, and regulations of governmental authorities having jurisdiction over this part of the work.
- D. Trench subgrade will be reviewed for elevation and stability.
 1. Elevation of trench bottom to be within a tolerance of one-half (1/2) inch from plan grade.
 2. Potential for trench undercutting will be reviewed by probing the trench bottom. Penetrations greater than six (6) inches below the specified subgrade elevation will prompt review by the Owner for potential undercuts.
- E. Compaction of Undercut Backfill, Bedding, and Initial Backfill will be visually observed to review installation in conformance with the project requirements.
- F. Compaction testing will be conducted on each lift of Final Backfill above the Pipe Zone, including the top of the Pipe Zone.
 1. Maximum lift thickness of final backfill is 12 inches unless otherwise detailed.

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2. Compact top of the Pipe Zone and Final Backfill materials to not less than 95% of the maximum unit weight as determined by the method described in the MDOT Density Testing and Inspection Manual appropriate for the backfill material.
3. Provide testing summaries for each day and type of compaction testing, each summary shall include, at minimum, the following:
 - a. Station and depth of where the test was taken from centerline of utility.
 - b. The specified material and type of material (if different) being tested and the measured maximum dry density, moisture content, and percent compaction.
 - c. Method of compaction testing.
 - d. All tests taken.

1.7 EXISTING CONDITIONS

- A. The Contractor will be held to have compared the conditions of the site where work is to be performed with the drawings and specifications and to have satisfied themselves as to the conditions of the site, existing conditions, and any other conditions affecting the carrying out of the work.
 1. It is expressly understood that the Contractor will obtain first-hand information concerning the available facilities for receiving, transporting, handling and storing construction equipment and materials and concerning other local conditions that may affect the Work.
 2. The Contractor shall draw their own conclusion as to soil and/or rock conditions and groundwater to be encountered, and shall complete the Work under any job or field condition which was present and/or ascertainable prior to bidding.
- B. The Contractor shall complete the work under whatever conditions created by their own sequence of construction, construction methods, or other condition created at no additional cost to the Owner.
- C. Contact Miss Dig (811) a minimum of 72 hours in advance of any excavation for the location of utilities and cable facilities.
- D. Utilities have been located from surveys and available existing records. Not all utilities may be shown on the Drawings. Locate all utilities prior to beginning trench excavation activities.
- E. Where utilities require adjustment, relocation, or support to construct the Work, and those utilities are shown on the Drawings, relocation, adjustment or support shall be considered included in the Work and shall be completed at no additional cost to the Owner.
- F. Where utilities require adjustment, relocation or support to construct the Work, and those utilities are not shown on the Drawings, notify Owner or Owner's Representative before proceeding.
 1. Relocate or adjust utility as directed.
 2. Utility relocation and/or adjustment will be paid for in accordance with the Contract provisions for changes in Work.
- G. If utility is damaged by Contractor, notify utility owner and Owner or Owner's Representative immediately. Repair or replacement of utilities damaged by Contractor, whether utilities are shown on the Drawings or not shown on the Drawings, shall be at the Contractor's expense.

1.8 POTENTIALLY HAZARDOUS SUBSTANCES

- A. Use the following indicators to identify materials suspected of being hazardous or contaminated and requiring disposal in a Type I or Type II landfill.
 - 1. Materials other than general construction debris of a color not consistent with the natural soils observed in the area;
 - 2. Materials other than general construction debris of a consistency that is not consistent with the natural soils observed in the area;
 - 3. Man-made containers, vessels, tanks, or barrels;
 - 4. Electric devices;
 - 5. Insulation or fibrous material that may contain asbestos;
 - 6. Material that emits a chemical or petroleum odor.

- B. Separately stockpile questionable materials.
 - 1. Inspected and representative samples should be collected and screened in the field.
 - 2. Materials should be stored on plastic sheeting at the predesignated, secure location on the parcel or an adjacent parcel and covered with plastic sheeting until disposal is determined.

- C. The Contractor will be responsible for identifying and testing of potentially hazardous materials and reporting to the Owner and Engineer.

- D. Potentially hazardous materials should be screened in the field by qualified personnel for the presence of volatile organic compounds (VOC) using a photoionization (PI) meter.
 - 1. It is assumed that the presence of VOCs should provide a general indicator of the presence of other potentially hazardous chemicals.
 - 2. Materials to be subjected to further laboratory analysis should be selected based on the results of the field screening and observations made by the person monitoring the excavation.

- E. Based on the field screening and laboratory analysis, the Contractor will be advised by the Owner as to the required method of disposal.

PART 2 PRODUCTS

2.1 UNDERCUT BACKFILL AGGREGATES

- A. Coarse graded aggregate to meet grading requirements as specified below.

- B. Slag and crushed concrete aggregates are prohibited.

- C. Aggregates to be supplied from approved manufacturers of prequalified aggregate sources, as identified in the MDOT Materials Source Guide, latest edition.

UNDERCUT BACKFILL GRADING REQUIREMENTS								
Material	Total Percent Passing (Sieve Size)							
	1 1/2"	1"	3/4"	1/2"	3/8"	No. 4	No. 8	Loss by Washing

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MDOT 6A	100	95-100	-	30-60	-	0-8	-	≤ 1.0
MDOT 17A	-	100	90-100	50-75	-	0-8	-	≤ 1.0

2.2 UTILITY BEDDING

A. Refer to specific pipe material specification for bedding material requirements.

2.3 UTILITY INITIAL BACKFILL

A. Refer to specific pipe material specification for initial backfill material requirements.

2.4 UTILITY FINAL BACKFILL

A. Final Backfill for utility trenches will be “Sand Backfill Trench” or “Standard Backfill Trench” as defined in Section 1.3.B

B. Granular materials used for Final Backfill in the “Sand Backfill Trench” shall meet the minimum requirements for granular material as specified on the following page:

FINAL BACKFILL SAND BACKFILL TRENCH GRADING REQUIREMENTS								
Material	Total Percent Passing (Sieve Size)							
	3”	2”	1”	1/2”	3/8”	No. 4	No. 100	Loss by Washing
MDOT Class II	100	-	60-100	-	-	50-100	0-30	0-7
MDOT Class IIA	100	-	60-100	-	-	50-100	0-35	0-10
MDOT Class IIIA	-	-	-	-	100	50-100	0-30	0-15

C. Final Backfill material used for the “Standard Backfill Trench” shall comply with;

1. Grading requirements as specified below, or
2. Definition of “Suitable Material” as described in Section 1.3.B.

FINAL BACKFILL STANDARD BACKFILL TRENCH GRADING REQUIREMENTS								
Material	Total Percent Passing (Sieve Size)							
	6”	3”	1”	1/2”	3/8”	No. 4	No. 100	Loss by Washing
MDOT Class II	-	100	60-100	-	-	50-100	0-30	0-7
MDOT Class IIA	-	100	60-100	-	-	50-100	0-35	0-10
MDOT Class III	100	100-95	-	-	-	50-100	-	0-15
MDOT Class IIIA	-	-	-	-	100	50-100	0-30	0-15

- D. Material not meeting the grading requirements for above may be used for Final Backfill provided the Contractor can supply test results showing conformance with the definition of “Suitable Material” as described in Section 1.3.B.
- E. Materials meeting any of the criteria for “Unsuitable Material” as described in Section 1.3.B are prohibited from use as Final Backfill.

2.5 APPURTENANT STRUCTURE BACKFILL

- A. Materials shall match condition and grading requirements detailed in “UTILITY FINAL BACKFILL”.

PART 3 EXECUTION

3.1 PREPARATION

- A. Plan construction to minimize disturbance.
- B. Protect adjacent structures, utilities, sidewalks, pavements and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations
- C. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent sites and walkways.
- D. Maintain normal flow of drainage water on the jobsite and all present above ground and underground utilities.
- E. Provide and maintain barricades, warning lights, warning signs, and other protection required by applicable laws for safety of persons and property.

3.2 DEWATERING

- A. Do not allow water to accumulate in the trench.
 - 1. Remove water that accumulates in the trench which would affect the construction of utilities or their appurtenant structures by pumping, bailing, well-pointing, draining or other approved dewatering method.
 - 2. Perform all work necessary to keep the trenches entirely clear from water throughout construction of utilities and appurtenant structures.
 - 3. Construction of structures in water is prohibited.
- B. Convey all water removed from trench in a proper manner to a suitable point of discharge that complies with applicable soil erosion and sedimentation control regulations.
 - 1. Dispose of water from the trench in such a manner to cause no injury to public health, property, work completed or in progress, street surfaces, or where such effluent may cause an interference with the use of the streets.
 - 2. If water is odorless and stable, discharge of the dewatering systems into an existing storm drain, channel, or street gutter in a manner approved by the Owner is permissible. Filtering of the discharge water is required.

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3. Discharge of water to a sanitary sewer main of sanitary sewer related structure is strictly prohibited.
- C. Maintain dewatering systems until dewatering is no longer required.
- D. Prevent surface water from ponding on prepared subgrades and from flooding the project site and surrounding areas. Reroute surface water runoff away from or around excavated areas.
- E. All shoring, sheeting, well-pointing, gravel bedding and other dewatering devices necessary to successfully complete the dewatering requirements of the project shall not be considered separate items of work but are inclusive to dewatering.

3.3 TRENCHING AND EXCAVATION

- A. Excavate utility trench width to at least the minimum width in conformance with the material specification and standard details for the associated pipe material type.
 1. If material specification and standard details are not provided, refer to manufacturer's recommended trench widths.
 2. Provide Owner with planned trench dimensions at Pre-Excavation meeting if different than material specification and standard details.
- B. All excavation of trenches is to be by open cut method, to the depth and grade shown on the Drawings and as necessary to accommodate the Work, unless otherwise noted.
- C. Excavate to the line and grade shown on the Drawings.
 1. Excavations shall be to depths to provide cover of five and one half (5½) feet over the top of pipe to plan grade, unless otherwise noted on the plans.
- D. Begin trench excavation at the downstream end of the utility, when applicable.
- E. Excavate in accordance with OSHA Standard 29 CFR Part 1926 – "Safety and Health Regulations for Construction".
- F. Do not stockpile materials along one edge of the excavation so as to impose too great a load on the bank of the trench or cause damage to trees, shrubs, fences or other property.
 1. Stockpiling of excess excavated materials in large piles will not be allowed without permission of the Owner.
- G. Excavate only as much trench as can be entirely completed (install utility, backfill, compact, clean up) within that working day.
 1. Do not open a greater length of trench than can be effectively utilized and maintained under existing conditions and with the forces at hand.
 2. Limit maximum allowable length of open trench to 50 linear feet per work crew.
 3. Remove all construction debris, equipment and excess dirt from the site.
- H. Contractor is responsible for proper disposal of excavated materials.
 1. Dispose of excess and unsuitable material in accordance with local, County, State and Federal Regulations.
 2. All excavated material removed offsite becomes the property of the Contractor.

- I. Preparation of Trenches for Utility Installation:
 - 1. Excavate the bottom of the trench to a minimum over depth as indicated in the material specification and standard details for the associated pipe type and laying condition specified to provide for pipe bedding.
 - 2. Shape the bottom of the trench to support the utility uniformly.
 - 3. Check the elevation of the excavation depth.
 - 4. Review the subgrade for stability.
 - 5. Remove all water from the trench prior to utility placing operation to ensure a dry, firm bed on which to bed the utility.
 - 6. Where unsuitable soil conditions, or obstructions other than ~~rock~~ *Rock*, require excavation of the trench below the subgrade elevation detailed on the Drawings; undercut, backfill and compact the trench as specified in Section 3.4

- J. Excavation for Structures:
 - 1. Excavate to provide a minimum of 12 inches of horizontal clearance between outer surface of structure and trench wall.
 - 2. Excavate the bottom of manhole bases and other precast structures and appurtenances to a minimum over depth of 6 inches below the bottom of the structure, or no less than indicated in the applicable standard details.
 - 3. Shape and grade the excavation so that the subgrade is level over the entire area.
 - 4. Check the excavation depth. Subgrade is required to be within 1/2-inch of elevation specified in the Drawings.
 - 5. Review the subgrade for stability.
 - a. Probe suitable soils that appear unstable.
 - b. Notify Owner if probe penetrations exceed six (6) inches.
 - 6. Remove all water from the excavation prior to placing the structure to ensure a dry, firm bed on which to install the base of the structure.
 - 7. Where unstable soil conditions, or obstructions other than rock, require excavation below the subgrade elevation detailed on the Drawings; undercut, backfill and compact the excavation as specified in Section 3.4.

- K. Once trench or excavation is open, proceed immediately to place specified materials in trench, or to otherwise utilize trench for its intended purpose.
 - 1. Schedule work and order materials so that trenches are not left open for a longer period of time than is reasonably necessary.
 - 2. Any trench or portion of trench, which is opened and remains idle for 24 hours or longer, as determined by the Owner, may be directed to be immediately refilled, without completion of work, at no additional cost to the Owner.
 - 3. Said trench may not be reopened until the Owner is satisfied that work associated with trench will progress to finish.

3.4 TRENCH UNDERCUT AND BACKFILL

- A. Notify the owner when any unsuitable soil conditions or obstructions are discovered at the bottom of the trench or appurtenant structure excavation.
 - 1. Undercut the subgrade only upon authorization of the Owner.
 - 2. Delineate and record limits of unsuitable materials.

- B. Excavate below the proposed subgrade elevation within the excavation limits until solid, suitable bearing material is uncovered.

- C. Fill the undercut excavation with approved aggregate material detailed in Section 2.1 to the proposed subgrade elevation.
 - 1. Maximum 12-inch lifts.
 - 2. Compact each lift to minimize voids.
- D. Suspend undercutting activities once a depth of 3 feet is reached to review the conditions with the Owner and, if necessary, consider alternative solutions.

3.5 ROCK EXCAVATION

- A. Should rock within the proposed trench excavation be encountered, payment for removal, disposal, and backfill of areas to properly support the utility or appurtenant structure shall be measured and paid for in accordance with the Contract provisions for changes in Work and as described in Section 1.2.
- B. Notify the Owner when rock within an excavation is encountered and prior to any blasting or removal.
 - 1. Do not perform rock excavation work until rock has been cross-sectioned, classified, and approved for removal by the owner.
 - 2. Owner will measure the rock, after which, the rock shall be excavated to a depth six (6) inches below the grade of the proposed utility and the bottom of the excavation brought back to grade by using the approved Undercut Backfill material.
- C. Intermittent drilling, blasting, or ripping performed to increase production and not necessary to permit excavation of rock encountered will be deemed to be an unauthorized excavation.
- D. Remove over-blasted rock which has been loosened prior to backfilling.
- E. Use overburden, mats, or other means to minimize fly-rock. Any damage caused by fly-rock or excessive vibration due to rock excavation activities will be the responsibility of the Contractor.
- F. Rock excavated from the trench shall be hauled off the site at the Contractor's expense.
 - 1. No rocks or boulders shall be used as backfill in any part of the trench.
 - 2. Where rock has scattered over adjacent lands as a result of blasting or rock excavation, Contractor shall remove the rock and restore area to its original condition at no cost to the Owner.

3.6 UNAUTHORIZED EXACAVTIONS

- A. Whenever the trench excavation is carried beyond the lines and grades established by the drawings or as approved by the Owner, the Contractor shall, at his own expense, fill all such excavated space with concrete cradling or other approved material and in such a manner as to meet the approval of the Owner.
- B. Unauthorized excavation beneath structures shall be filled with plain concrete, or flowable fill as determined by the Owner.

3.7 SHORING, SHEETING AND TRENCH BOX CONSTRUCTION

- A. Shoring and Sheeting
 - 1. Refer to specific sheeting and shoring specifications for minimum requirements braced excavation design and installation.
 - 2. Sheet and brace excavations as necessary to ensure substantial completion of the work and ensure the safety of the workers and the public and to protect existing structures
 - 3. Sheeting and shoring placed in the trench's Pipe Zone shall be left in place or cut off not lower than the top of pipe.
- B. Trench Boxes
 - 1. It is the Contractor's responsibility to determine the necessity of using a trench box for excavation.
 - 2. Ride trench box above the top of pipe to maintain the design trench width up to the top of pipe.
 - 3. Protect the integrity of the pipe bedding.
 - 4. Care must be taken to ensure that movement of the trench box does not pull the pipe joints apart.

3.8 UTILITY BEDDING

- A. Refer to specific pipe material specification for Bedding installation requirements.

3.9 INITIAL BACKFILL

- A. Refer to specific pipe material specification for Initial Backfill installation requirements.

3.10 FINAL BACKFILL

- A. Place Final Backfill using mechanical compaction method in layers not to exceed 12 inches.
- B. Compact each layer of Final Backfill to not less than 95% of the maximum unit weight of the selected material as specified in Section 1.6.
- C. It is the Contractor's responsibility to provide safe and secure access for testing personnel to complete the specified testing requirements.
- D. Backfill to the top of the excavated trench and compact all backfill for the utility installed during the same day, prior to completion of the day's work to provide a firm continuous support and covering for the utility.
- E. Do not operate heavy equipment or vibratory equipment over any utility until it has been properly backfilled and compacted to minimum required maximum unit weight and has a minimum of 48 inches of cover.
- F. Place backfill around structures in a manner that will not cause unequal pressure or damage to any exterior coatings, plastering or parging.
- G. Compaction by flooding the excavation is prohibited.

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3.11 NON-CONFORMING WORK

- A. Re-excavate trenches that have been improperly backfilled and replace and re-compact
- B. Should any of the Work be so enclosed or covered up prior to compliance with the quality assurance requirements of these specifications, such Work shall be uncovered and after quality control testing, refilled and compacted all at no additional cost to the Owner.
- C. Remove and replace pipe that shows excessive settlement or has been otherwise damaged by Contractor's operations at no cost to the Owner.

END OF SECTION

SECTION 02368

BRACED EXCAVATION

a. Description

This work consists of designing, furnishing, installing, maintaining, removing and/or cutting off the soldier pile and lagging braced excavation, anchors, deadman, walers, related materials, and equipment required to maintain support of the braced excavation and adjacent embankment and coordinated with the staged construction requirements at this site. This includes signed and sealed designs calculations and shop drawings by the Contractor's Registered Professional Engineer currently licensed in the State of Michigan. Perform the work in accordance with the Braced Excavation Design Criteria shown on Sheet S-8 of the Drawings and this Section.

Braced excavation for structure excavations in soil shall consist of soldier piles and lagging, steel ribs and timber lagging, ribs and steel liner plates or comparable systems. Installation of vertical steel sheet piling for braced excavation shall not be permitted.

Braced excavation denotes temporary braced excavation. Temporary braced excavation shall consist of temporary braced excavation removed after usage or temporary braced excavation to remain permanently in place. Limits for each type of excavation shall be as noted on the Drawings.

b. Design Qualifications

Ensure that the design is prepared by the Contractor's designer; and the designer is a Professional engineer, currently licensed in the State of Michigan. Submit the design and supporting calculations to the Engineer for review and approval not less than 30 calendar days prior to beginning of work. All submittals are to be as a portable document format (PDF) file to the Engineer. Paper sets are prohibited. Obtain the Engineer's approval of the braced excavation design prior to beginning installation. The Owner will require 10 calendar days for each review cycle and revision may be required following each review. No extension of time or additional compensation will be granted due to delays in preparing the final working drawings, calculations and material specifications or securing approval for the Owner. An exception may be granted for an extension of time only in the case that the Owner's review of a submittal exceeded 10 calendar day and if it can be shown that such a delay impacts the final project completion date.

Provide the following documentation for the braced excavation designer:

1. The braced excavation design shall be prepared and sealed by a Professional Engineer licensed in the State of Michigan with at least 5 years of experience and have designed braced excavation systems for 5 projects of similar depths, complexities and in similar ground conditions as the systems to be used for this project.
2. The Professional Engineer shall provide Professional Liability Insurance of at least \$2 million.
3. The qualifications and insurance shall be submitted to the Owner for review prior to the pre-construction meeting and prior to performing designs.

The contractor shall submit the name and qualifications of their proposed braced excavation designer with their bid. Any changes to the braced excavation designer after the bid must be reviewed and approved by the Owner.

c. Design

Select methods of braced excavation that are compatible with conditions described in the contract Geotechnical Report, and with requirements for placement of permanent structures, control of water, safety of personnel, and protection of adjacent property.

Braced excavation systems shall maintain the safety of personnel, prevent damage to adjacent property, and maintain the inherent strength and stability of ground surrounding the excavation. Braced excavation systems shall prevent ground loading on the new Work until after design strength has been reached.

Contractor shall be solely responsible for design of the braced excavation. The design shall be prepared and sealed by the Contractor's registered Professional Engineer currently licensed in the State of Michigan, having at least 5 years of experience designing similar support systems in similar ground conditions.

Braced excavations shall be designed to the minimum ground loads, hydrostatic loads, and surcharge loads provided in the Contract Geotechnical Report and per the Braced Excavations – Design Criteria on the Plans. Contractor shall verify that ground loads and surcharge loads for design are adequate for the expected ground conditions, and are appropriate for the type of support system proposed. Contractor shall add construction loads appropriate to the means and methods of construction.

Design of the braced excavation shall consider:

1. Ground conditions describe in the Contract Geotechnical Report
2. Methods for control of water
3. Maintenance of soil stability at the bottom of the excavation
4. Deformation of the braced excavation system under load
5. The proximity of existing underground and above-ground structures, including buried water lines and gas lines, and the potential effect of their rupture.
6. Effects of vibration on adjacent structures, from driving and pulling of soldier piles.
7. All loading conditions, including loading due to delay in adding support members removal of support members, and dynamic loading.
8. Placement of permanent lining and structures.

Note: Driving of vertical steel sheet piling shall not be permitted.

Submittals: Submit drawings, computations, and supporting information describing support systems for excavations, in sufficient detail to demonstrate conformance with regulatory requirements. Designs shall be signed and sealed by the Contractor's Registered Professional Engineer currently licensed in the State of Michigan.

Submit noise and vibration monitoring plan, addressing each site where monitoring requirements apply, prior to construction.

Submit noise and vibration monitoring results for monitoring performed each week.

Submit mix designs for flowable fill, drilled pier fill, contact grout, annular grout, concrete collar, drilling template concrete, and other applicable mix designs.

d. Materials

Timber Lagging: Wood graded for an extreme fiber bending stress of at least 1,600 psi. Timber dimension shall be 4”x6” nominal with maximum 6’-0” long. The material for timber lagger shall be beech, hickory or oak hardwood.

Internal Bracing System:

1. Structural Steel: The material in walers, struts, pile bracing, points, caps, and splices shall be structural steel as follows:

Wide Flange Shapes	ASTM A992
HP Shapes, Angles, Channels and Plate	ASTM A36
Pipe, Pipe Columns, Bollards	ASTM A53, Type E or S, Grade B standard weight unless noted otherwise
HSS	ASTM A500 Grade B

2. Bolts for connections shall be ASTM F3125, unless indicated otherwise. Bolts used to connect dissimilar metals shall be ASTM A193 and A194, Type 316 stainless steel.
3. Structural members shall be furnished full length without splices unless otherwise indicated or approved by the Engineer.

e. Construction

Construct braced excavations to line, grade, dimensions, and tolerances that allow permanent structures and pipes to be places as shown on the Drawings and in accordance with specified tolerances. Braced excavation shall not project into the limits of the permanent structure.

Supplement the support system as designed to address variations in ground conditions as they are exposed in the excavation.

Install and remove support members following the sequence of operations shown on the Contractor’s design drawings.

Develop and maintain firm and uniform bearing of the braced excavation against the ground by advancing the support system in advance of excavation, by timely placement of internal supporting members, by expanding the support system tightly against the ground, or by timely backfill grouting between a non-expanding support system and the ground.

Periodically examine braced excavation in place to identify loosening or instable ground; loss of ground through the support system; or excessive deformation, overstress, or weakening of the support system.

Soldier Piles:

Maintain the initial ground support system in fully functional condition for the duration of its use. Promptly reset, repair, or replace support system elements that settle, become misaligned, were improperly installed, or become damaged.

Install soldier piles by pre-drilling to their proposed tip elevations. Impact and vibratory driving for soldier piles installation is prohibited.

Within the same day of seating the soldier piles in the pre-excavated holes, completely backfill the holes and fully encase the soldier piles with concrete of class as specified in the Contract Documents from the pile tip to the ground surface.

After completion of structure construction and excavation backfilling, soldier piles shall be left in-place and cut off at a minimum 6' below finished grade, unless specified otherwise on the Drawings.

Timber Lagging:

Install lagging with louvered openings (gaps) between boards in accordance with ground conditions encountered in excavation and subject to the approval of the Owner. In no case will the louvered openings be allowed to exceed one (1) inch.

Pack louver openings between lagging with filter fabric, hay, excelsior erosion control matting, jute matting, or other porous material to allow free drainage of groundwater without loss of retained soil or back packing.

The maximum permissible height of unlagged (unsupported) face of excavation shall not exceed three (3) feet in sandy soils. If water is flowing from the face of the excavation, or if to be retained moves toward the excavation, the maximum height of unlagged face shall not exceed eight (8) inches. Except as otherwise specified, in no case shall more than five (5) feet of soil excavation height be unsupported at any time.

If unstable ground is encountered, take suitable measures (Backfill Grouting or other approved method) to retain the material in-place and prevent loss of ground or movements which may cause damage to adjacent structures or utilities.

Internal Bracing System:

Install and maintain support members in tight contact with each other and with surface being supported.

Structural members shall be adequately braced against buckling, with a factor of safety of at least 1.5 for maximum axial loading conditions plus bi-axial bending, including temperature effects.

Where required, pre-load bracing members in accordance with methods, procedures and sequence as described on approved shop drawings. Coordinate excavation work with installation of bracing and preloading. Use steel shims and steel wedges, welded or bolted in place, to maintain preloading force, where required, in bracing after release of jacking equipment pressure.

END OF SECTION

SECTION 02511

HOT MIXED ASPHALT PAVEMENT

PART 1 GENERAL

1.1 SUMMARY

- A. This Section shall include all work, materials, labor, and equipment necessary to furnish and install Hot Mix Asphalt (HMA) on a prepared base to the line, grade, thickness and cross-section in accordance with these specifications and drawings.
- B. Contractor to hire an acceptable testing firm and pay for all Quality Control and Quality Assurance testing.
- C. Related Requirements:
 - 1. Section 02200 – Earthwork
 - 2. Section 02214 – Roadway Excavation, Backfill, and Compaction

1.2 REFERENCES

- A. Abbreviations and Acronyms
 - 1. ASTM - American Society for Testing Materials
 - 2. HMA – Hot Mix Asphalt
 - 3. MDOT - Michigan Department of Transportation.
 - 4. MIOSHA – Michigan Occupational Safety and Health Act
 - 5. MMUTCD – Michigan Manual of Uniform Traffic Control Devices
 - 6. JMF – Approved Job Mix Formula
- B. Definitions
 - 1. Subgrade – Portion of the earth grade upon which the pavement structure is placed.
 - 2. Subbase – Layer of granular material placed on the subgrade as a part of the pavement structure.
 - 3. Open Graded Drainage Course – Layer of specified open-graded aggregate material placed on the subgrade as part of the pavement structure.
 - 4. Aggregate Base – Layer of dense graded aggregate material placed on a subgrade, subbase or open graded drainage course as part of the pavement structure.
 - 5. HMA base course – Layer below the leveling course for pavements in which there are three specified layers.
 - 6. HMA leveling course - Layer below the top course for pavements in which there are two or three specified layers.
 - 7. HMA top course – Layer that forms the pavement surface.
 - 8. HMA patch – an HMA repair of a small localized defect in the pavement surface either as planned or as created by defective material that needs to be removed or replaced.
- C. Where referenced, “MDOT Specifications” is a general term that shall include the current version of the MDOT Standard Specifications for Construction and all Supplemental

Specifications, Special Provisions, and Errata existing at the time of the award of the Contract.

- D. MDOT manuals that are referenced specifically by name shall be the current versions of said manuals existing at the time of the award of the Contract.

1.3 PREPRODUCTION MEETING

- A. The Engineer reserves the right to schedule a pre-production meeting. The pre-production meeting will be held a minimum of 7 calendar days prior to the start of HMA production and placement. The Engineer will provide written notification to all parties a minimum of 14 calendar days prior to the meeting. Items of discussion shall include, but not be limited to:
 - 1. Project safety.
 - 2. Project mixture and testing Special Provisions.
 - 3. Job Mix Formula.
 - 4. HMA sampling and testing requirements and procedures.
 - 5. Sequence of operations.
 - 6. HMA placement methods.
 - 7. The Contractor's HMA-QC/QA Plan.
 - 8. The roles and responsibilities of all parties involved in the work.
 - 9. HMA acceptance criteria.
 - 10. Project documentation.

1.4 SUBMITTALS

- A. Submit Bond Coat supplier and manufacturer data that includes test results for the properties indicated in the Tables titled "Anionic (Cationic) Emulsified Asphalts" in the MDOT Specifications.
- B. Submit documentation of Plant Certification for the current year – per Table 1-1.
- C. Submit HMA Plant Scale Calibration Certificate for the current year.
- D. Submit JMF for all HMA mixtures for review by the Engineer prior to construction.
 - 1. Submit the JMF on an MDOT Form 1911 that has been signed by an MDOT Traveling Bituminous Inspector for the current year and has been modified for this project or submit JMF on suppliers form (s) with the information listed per Table 1-1.
 - 2. Submit performance graded binder test results from the current year if requested by the Engineer.
- E. Submit testing firm with 10+ years' experience in testing HMA and a field technician with 3+ years of HMA testing experience, for Engineer's approval.

1.5 QUALITY CONTROL

- A. Quality control of all materials used on the project and methods of installation shall be the responsibility of the Contractor. The Engineer retains the right to perform random

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independent testing for the Engineer's assurance the project is compliant at his tested locations however contract compliance remains the responsibility of the Contractor.

- B. It shall be the responsibility of the Contractor to correct or suspend operations, if necessary, when the work is not in compliance with these specifications.

1.6 QUALITY ASSURANCE

- A. The Contractor will inspect, sample, test and evaluate the HMA for compliance to these specifications for the following:
1. Delivery and Placement Temperature
 - a. The Contractor will make periodic checks for temperature using a calibrated thermometer or temperature gun at locations within the truck, paver hopper or within the mat at the discretion of the Engineer.
 - b. Refer to Section 3.5.A and Table 3-1 for allowable temperature ranges.
 2. Layer Thickness and Yield
 - a. The Contractor will conduct periodic mat thickness depth checks and yield calculations during placement of the HMA material.
 - b. Lower layers of HMA base course are to be constructed to a tolerance of $\pm 3/4$ inch and final layers of base course constructed to a tolerance of $\pm 3/8$ inch.
 - c. HMA leveling course is to be constructed to a tolerance of $\pm 1/4$ inch.
 - d. HMA top course is to be constructed to a tolerance of $\pm 1/8$ inch.
 - e. The cumulative pavement thickness shall be at least the planned thickness and not be more than $1/4$ inch greater than the planned thickness.
 - f. The pavement thickness of a single course pavement shall be at least the planned thickness and not be more than $1/4$ inch greater than the planned thickness.
 3. Joint Quality: The Contractor shall visually inspect the joint configuration and placement for tightness, smoothness and alignment to evaluate conformance to the requirements stated in Sections 3.5 C.5 and 3.5 D.
 4. Surface Texture (segregation)
 - a. The Contractor shall visually inspect the surface texture to evaluate conformance to the requirements of Section 3.5 C.6.
 - b. Areas that visually appear to be segregated shall be evaluated by the Contractor by taking a set of 6 to 15 tests with a nuclear density gauge in both the visually segregated area and in an adjacent non-segregated area with the mean value of density of the two areas compared using the MDOT BITSEG2 computer program.
 - c. HMA that generates an output from the MDOT BITSEG2 program of "Remove and Replace, take corrective action" or "take corrective action" shall be considered to be segregated.
 5. Surface Smoothness: The Contractor shall visually inspect and make measurements to evaluate conformance to the requirements of Section 3.5 C.6.
 6. Density
 - a. HMA base, leveling and top course placed for both main line and hand patching shall be compacted to a minimum of 92.0% and a maximum of 96.0% of the density calculated from the theoretical maximum specific gravity (G_{mm}) indicated on the approved JMF for the mixture.

- b. The compaction percentage shall be determined by a calibrated nuclear density gauge.
 - c. The compaction percentage may be determined by 6 inch diameter cores (using dried back weights) at the discretion of the Contractor.
7. Longitudinal Joint Density
- a. Longitudinal Joints in HMA base, leveling and top course shall be constructed so that the density of the joint is a minimum of 84.0% of the density calculated from the theoretical maximum specific gravity (G_{mm}) indicated on the approved JMF for the mixture.
 - b. The compaction percentage shall be determined by a calibrated nuclear density gauge centered on the line where the joint between the two adjacent lifts abut at the surface.
 - c. Cores will not be permitted to establish the density and compaction % of longitudinal joints in HMA base, leveling or top course.
8. Mixture Properties
- a. The Contractor shall obtain samples of the hot mixture from the plant and test the mixture to evaluate compliance to the JMF.
 - 1) A single sample shall be obtained from each day's placement for each mixture type being placed that is under 100 tons.
 - 2) Two samples shall be obtained from each day's placement for each mixture type being placed that exceeds 100 tons.
 - b. The tested mixture properties shall be within the following tolerances during construction:
 - 1) Gradation of aggregate blend
 - a) Each sieve shall be within the Uniformity Tolerance indicated in Table 3-3.
 - 2) Binder content
 - a) Shall be within $\pm 0.5\%$ of that indicated on the JMF
 - 3) Air Voids.
 - a) Shall be within $\pm 1.0\%$ of the JMF value
 - 4) Voids in Mineral Aggregate (VMA)
 - a) Shall be within $\pm 2.0\%$ of the JMF value
- B. Testing Agencies: The Contractor shall employ an independent testing agency to do testing for in place density and mixture properties as directed by the Engineer.
- C. Destructive Testing: Destructive testing may be necessary during the term of the Contract to ensure that results as performed during the construction is deficient and warrants additional testing. The contractor shall be solely responsible for all costs incurred to perform destructive testing, including but not limited to the costs related to the testing of the areas suspected of failing to meet the contract requirements in a means approved by the Engineer, to retain experts to direct the method of testing, oversee the testing, and assist in the resolution of the deficient areas solely at the contractors expense. Should the destructive testing results provide supplemental information that the areas being tested were in compliance with the Contract requirements; the Contractor shall be compensated for the costs incurred in a method mutually selected by the Engineer and the Contractor from Section 00700 – General Conditions.

PART 2 PRODUCTS

2.1 BOND COAT

- A. Shall meet the requirements of type SS-1h as specified in the table Titled “Anionic Emulsified Asphalts” or type CSS-1h as specified in the table Titled “Cationic Emulsified Asphalts” in the current version of the MDOT Specifications.

2.2 HMA MIXTURES

- A. Mixing Plants
 - 1. Submit documentation of plant certification by MDOT. If certification cannot be provided, the Engineer may request samples of the materials to be used to be provided and tested to verify the properties of the submitted JMF prior to HMA being placed. See Table 1-1.
 - 2. Scales for weighing HMA mixtures must meet requirements of the section titled “Measuring Weight on Scales” of the MDOT Specifications.
- B. Composition of Mixture
 - 1. Provide the HMA mix type and the performance grade of asphalt binder as shown on the project plans and as described on the approved JMF.
 - 2. Aggregates
 - a. Shall be natural aggregates, iron blast furnace slag, reveratory blast furnace slag or steel furnace slag.
 - b. Gradation shall be within the range for each sieve size as indicated Table 2-1.
 - c. Physical Requirements shall be as indicated in Table 2-2.
 - d. The minimum Aggregate Wear Index (AWI) for aggregates used in HMA Top Course mixtures shall be 220, unless otherwise specified.
 - e. The Engineer reserves the right to request test results for and/or sample and test aggregates used in HMA Mixtures to establish compliance to these requirements prior to or during the production of HMA mixtures.
 - 3. Binder
 - a. Shall comply with the requirements indicated in Table 2-3.
 - b. Shall be from a supplier listed on the MDOT “Asphalt Binder Suppliers List” existing at the time of the contract award:
 - c. The Engineer reserves the right to request test results for and/or sample and test binders used in HMA Mixtures to establish compliance to these requirements prior to or during production of HMA mixtures.
 - 4. Mineral Filler
 - a. Shall be 3MF mineral filler consisting of limestone dust, dolomite dust, fly ash collected by an electrostatic precipitation method, slag, or hydrated lime.
 - b. Shall have a gradation with 100 percent passing the No. 30 sieve and 75 to 100 percent passing the No. 200 sieve.
 - c. Free carbon content of the fly ash sample shall not exceed 12 percent by weight as measured by the loss on ignition tests in accordance with ASTM C311.

- C. Mix Design Criteria and Volumetric Properties shall meet the requirements indicated in Table 2-4.
- D. Reclaimed Asphalt Pavement (RAP) Substitution
 1. Is limited to a maximum of 15% of the total mixture in HMA top course.
 2. Is limited to a maximum of 30% of the total mixture in HMA leveling and base course.
 3. Is limited to a maximum of 17% RAP binder by weight of the total binder in HMA mixtures where polymer modified binders are specified (designated P).
 4. No adjustment shall be permitted for the binder grade selection.

2.3 PAVING EQUIPMENT

- A. Paving equipment shall be in good working order and capable of constructing HMA pavement in accordance with the specifications. Should the HMA paving indicate that an equipment problem is causing the construction to be out of specification, the Engineer has the right to request the equipment be repaired or replaced.
- B. If maintaining traffic in the work area during construction, all self-propelled equipment within the construction influence area shall be with all safety devices as required by MIOSHA, MMUTCD, MDOT, or the local any governmental agencies within the construction influence area.

PART 3 EXECUTION

3.1 EXAMINATIONS

- A. Each layer of HMA shall not be placed until the surface upon which it is to be placed has been inspected by the Contractor immediately prior to continuing construction.
- B. The Contractor provides independent testing at random locations to assist in determining the conditions at the point the test is performed, but the Contractor shall remain solely responsible for compliance to the contract provisions throughout the entire project area.

3.2 PREPARATION OF SURFACES

- A. Subgrade
 1. Prepare subgrade in accordance with Section 2200 and Section 2214 of the Specifications.
 2. Grade subgrade to within one-half inch in ten feet of the design grade.
 3. Compact the subgrade, to a depth of not less than nine inches, to not less than 95% of the maximum unit weight as determined by the method described in the MDOT Density Testing and Inspection Manual appropriate for the subgrade material. The Engineer may require the maximum unit weight to be determined by ASTM D1557 or by other methods.
 4. Proof roll all subgrade using rubber-tired equipment of sufficient size and weight, as determined by the Contractor, to identify any soft or yielding soils that require undercutting.

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5. Undercut and replace soft or yielding soils in the subgrade using the specified materials and to the limits as directed by the Engineer.
- B. Subbase
1. Grade the subbase to within three-eighths of an inch in ten feet of the design grade.
 2. Compact the subbase to not less than 97% of the maximum unit weight as determined by the method in the MDOT Density Testing and Inspection Manual appropriate for the subbase material. The Engineer may require the maximum unit weight to be determined by ASTM D1557 or by other methods.
- C. Open Graded Drainage Course: Grade and compact the open graded drainage course to the design grade so that the finish surface is smooth and uniform in appearance without, depressions, ruts or ridges.
- D. Aggregate Base
1. Place the aggregate base to the line and grade as shown on the contact documents to within a tolerance of +/- 3/8 inch, unless otherwise specified.
 2. Compact the aggregate base to not less than 98% of the maximum unit weight as determined by the method in the MDOT Density Testing and Inspection Manual appropriate for the aggregate base material. The Engineer may require the maximum unit weight to be determined by ASTM D 1557 or by other methods.
- E. Existing Pavement Surfaces
1. An existing pavement surface may include a newly placed layer of pavement, the surface of an existing pavement without modification, or the existing pavement that has been removed in part with the use of a cold milling machine or by other approved means.
 2. Adjust all structures to finished grade prior to placement of HMA top course, matching both the design longitudinal and transverse cross slopes. Utilization of ductile iron frame adjustment rings for placement of HMA top course will be required unless otherwise approved.
 3. Remove existing cold patch.
 4. Remove existing joint sealants to a depth of up to one inch, vegetation, or such dirt and debris from transverse and longitudinal joints and from cracks by mechanical or hand methods.
 5. Thoroughly clean the surface of the pavement and paved shoulders of all dirt and debris. All cracks and joints shall be blown with compressed air to remove any loose material. A self-contained vacuum sweeper shall be used to pick up all loose material.
 6. Full Depth Patch Removal: Remove full depth existing patches, when directed by the Engineer, by providing a full depth saw cut around the area to be removed and remove existing materials and dispose of off-site.
 7. Hand Patching
 - a. Fill in holes and depression and replace full depth existing patches and joint repairs when directed by the Engineer using the HMA mixture specified in the contract documents. Compact the full depth hand patching material in layers no greater than 3 inches to the adjacent pavement grade by the use of an approved roller or by vibratory plate compactors or other means approved by the Engineer for areas not accessible to a roller.

- b. The Contractor shall use an Engineer approved HMA top course material. HMA mixtures 2C, 11A, and 700B shall not be permitted for hand patching.

- F. Other Surfaces: Where included in the design pavement cross-section on the Contract Drawings, HMA pavement may be placed on other surfaces for certain road rehabilitation projects, which may include cold milling, and pulverized or rubblized HMA or concrete pavement. For these projects, special provisions or specifications are included in the Contract Documents detailing the requirements for preparation of those surfaces.

3.3 BOND COAT

- A. Uniformly apply bond coat to the surfaces against which new HMA is to be placed with a pressure distributor.
- B. The surfaces against which new HMA is to be placed shall be clean and dry. Contact surfaces that have become coated with dust, sand, or other objectionable material shall be cleaned by brushing, blowing with compressed air, or cut back with an approved power saw or other mechanical means to achieve a smooth clean edge, as directed by the Engineer.
- C. The bond coat shall be applied far enough in advance of placement of the fresh mixture to insure adequate curing. Reapplication of the bond coat may be required at the direction of the Engineer if it becomes contaminated prior to placement of the HMA mixture.
- D. At no time shall bond coat be applied to the vertical face of concrete curb and gutter or monolithically poured face curb.

3.4 TRANSPORTATION OF MIXTURES

- A. Each load of HMA mixture delivered to the project shall be weighed to the nearest 20 pounds on a certified scale having an automatic print out system.
- B. Trucks used for hauling HMA mixtures shall have tight, clean, smooth beds and shall be adequately covered to protect from the weather and foreign objects.
- C. Trucks used to haul HMA mixtures when the air temperature is below 50 degrees F. shall be insulated. The insulation shall be continuous along the bottom and four sidewalls.
- D. A release agent, as permitted by the Engineer shall be applied to the hauling units with atomizing spray equipment. Excessive use of release agent will be cause for rejection of the load.

3.5 INSTALLATION

- A. HMA Delivery at Site
 - 1. The temperature of the HMA mixture discharged from the hauling unit shall be within the ranges indicated in Table 3-1 unless otherwise approved by the Engineer or they may be rejected.

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2. Where there is no range specified in Table 3-1 for surface temperature and layer thickness, placement shall not be permitted unless approved by the Engineer.
3. Any load having a temperature below 250 degrees or above 350 degrees in the hauling unit will be rejected.

B. Temperature of Surfaces Prior to Placement – See Table 3-1

C. Placing HMA Mixtures

1. Pavers
 - a. HMA shall be placed by an approved self-propelled mechanical paver to such a depth that when compacted it will have the thickness specified or as directed by the Engineer. The mixture shall be dumped into the center of the hopper and care shall be exercised to avoid overloading the paver and spilling the mixture.
 - b. Pavers will be required to have an automatically controlled and activated screed and strike off assembly except when placing HMA mixtures for:
 - 1) Variable width sections.
 - 2) The first course of an HMA base course mixture on a subgrade, subbase or aggregate base.
 - 3) HMA base course mixtures for shoulders and widening less than 10.5 feet in width or as directed by the Engineer.
2. HMA Shoulders: Shoulder widths within the tolerance of the equipment shall be placed with the main line HMA Top Course mixture. Shoulder widths exceeding the capabilities of the equipment shall be placed with an acceptable paver as directed by the Engineer.
3. HMA Wedging
 - a. When necessary to take out irregularities in the existing road surface, wedging with HMA mixture shall be done by placing several layers with the paver.
 - b. The nominal maximum aggregate size for the material used shall not exceed $\frac{3}{4}$ inch and the maximum lift thickness shall be 2 inches. HMA Mixtures 2C, 11A and 700B will not be permitted for wedging.
 - c. Any corrections made by wedging with HMA mixture shall be placed, compacted, and allowed to cool prior to placing leveling, or top course mixtures. If the surface temperature of the wedging material falls below 150° F then a bond coat shall be applied prior to placement of the next layer of pavement.
4. HMA Lift Thickness
 - a. HMA base course shall not be placed in lifts exceeding 3 inches, compacted, unless otherwise approved by the Engineer. Approval to place lifts in excess of 3 inches will be based on the ability of the Contractor to place and compact the HMA base course mixture to the required density, cross section, and within the specified tolerances
 - b. When the lift thickness exceeds 2 inches for HMA top course mixtures and 2 $\frac{1}{2}$ inches for HMA leveling course mixtures, the pavement shall be constructed in two or more courses, unless otherwise specified in the contract documents.
5. HMA Joints
 - a. When placing the HMA top course, or the top 2 courses of multi-level pavement on the traveled portion of the roadway, the paving operation

- shall be conducted in a combination of widths which will cause the final course longitudinal joint lines to coincide with the proposed painted lane lines.
- b. In placing HMA mixture adjacent to all joints, hand raking or brooming will be required to provide a dense smooth connection.
 - c. All joints shall have the same texture and smoothness as other sections of the layer.
 - d. The interface between the HMA mixture and concrete surfaces shall be full depth saw cut to a minimum width of ¼ inch and sealed with a hot poured rubber sealant.
 - e. Transverse Joints
 - 1) The roller shall pass over the unprotected end of freshly placed mixture only when placing of the layer is discontinued or when delivery of the HMA mixture is interrupted.
 - 2) In all cases, the edge of the previously placed layer shall be cut back to expose a clean, even, vertical surface for its full thickness.
 - 3) In continuing placement of a strip, the mechanical hot mixture will be spread to obtain a joint after rolling which conforms to the required density and smoothness specified.
 - f. Longitudinal Joints
 - 1) Longitudinal joints shall be vertically aligned to be within 1 inch of the underlying course and aligned with the final pavement markings.
 - 2) Inclusion of pay item for “HMA Longitudinal Joint – ft” indicates that longitudinal joints in the HMA top course shall be saw cut and sealed with hot poured rubber sealant, as shown in the project plans.
 - 3) Edges of previously placed strips that have cooled or are irregular, honeycombed, poorly compacted, damaged, or otherwise defective, and unsatisfactory sections of the joint shall be cut back to expose a clean, sound, vertical surface for the full thickness of the course as directed by the Engineer.
 - 4) When placing HMA over a concrete pavement, the longitudinal joints shall align with the joints in the concrete pavement. It shall be the responsibility of the contractor to provide the precise location of the existing longitudinal joints prior to placement of the HMA. In no case shall the variance between the underlying longitudinal joints and the HMA longitudinal joints exceed 1 inch. The longitudinal joints in the HMA shall be saw cut and sealed with hot poured rubber sealant.
 - g. When the temperature of the previously placed HMA mixture mat falls below 170 degrees F. The edges of the previously placed HMA mixture mat shall be coated with bond coat material before the new HMA mixture is placed on the adjacent section.
6. HMA Surface.
- a. A sufficient number of experienced shovelers and rakers shall follow the machine, adding hot HMA mixture and raking the HMA mixture as required to produce a course that, when completed, will conform to all requirements specified herein. Broadcasting or fanning of HMA mixture

over areas being compacted will be permitted for HMA base and leveling course but shall not be permitted for HMA top course.

- b. In areas where the use of machine spreading is impractical, the HMA mixture shall be spread in a manner to prevent segregation.

D. Rolling and Compaction of HMA Mixtures

1. Rollers and Rolling – General

- a. Use roller type indicated in Table 3-2 for the appropriate application.
- b. The Contractor shall provide an adequate number of rollers so as to achieve the minimum required density and finish, adjusting the speed of the paving operation as needed.
- c. Pneumatic-tired rollers shall not mark or rut the surface or displace the pavement edges. The pneumatic tired roller shall be ballasted to obtain the required ground contact pressures as directed by the Engineer. In order to obtain a uniformly textured mat and the desired in place density, the Engineer may direct the Contractor to correct any deficiencies that arise at any time during the rolling operations. The roller operations shall be conducted in such a manner as to prevent scuffing or chatter marks in the pavement surface.
- d. Steel rollers wheels shall be kept properly moistened with water but usage of an excess is prohibited. Pneumatic tired rollers shall be inspected and be verified to be clean.
- e. Rolling of the HMA mixture shall begin as soon after placing as it will bear the roller without undue displacement, picking up the mat or cracking. Rolling can start longitudinally at the extreme sides of the lanes and proceed toward the center of the pavement, overlapping on successive trips by at least half the width of the drive wheel of the roller. Alternate passes of the roller shall be of slightly different lengths. The maximum roller speed shall not exceed the manufacturer's recommended speed for the type of mixture or thickness of layer being placed. At no time shall the roller finish perpendicular to the direction of travel.

2. Rolling and Compacting Unsupported Edges: When placing the HMA Mixture at an unsupported edge, the drum on the first pass at an unsupported edge shall be 3 inches to 6 inches inside the unsupported edge. On the second pass at an unsupported edge the drum shall extend over the unsupported edge by approximately 6 inches. The drum shall not run on the edge or directly inside the unsupported edge.

3. Rolling and Compacting Joints: When placing the HMA mixture in a lane adjoining a previously placed lane (longitudinal joint), the mixture shall be placed such that it uniformly overlaps the first lane by a maximum of two inches and is placed at a height above the cold mat equal to the breakdown roller depression on the hot mat. Compact the longitudinal joint by rolling from the hot side, keeping the edge of the roller approximately 6 inches to 8 inches inside the cold joint for the first pass. For the second pass of the roller, compact the joint from the hot side while overlapping the cold side by 6 inches to 8 inches.

4. Rolling and Compacting Areas of Limited Accessibility: In all places not accessible to the roller and less than 3 feet in width, the hot HMA mixture shall be compacted by vibratory plate compactors or by other means approved by the Engineer. Skin patching on an area that has been rolled will not be permitted.

5. HMA Surfaces

- a. After final rolling, the surface may be tested by the Contractor using a 10 foot straight edge supported on equal size blocks 1 inch or greater in thickness at each end at selected locations. The variation of the surface from the testing edge of the straight edge between any two contacts with the surface shall at no point exceed:
 - 1) Three-eighths inch for HMA base course.
 - 2) One-quarter inch for HMA leveling course.
 - 3) One-eighth inch for HMA top course.
- b. Finish rolling on the top course shall continue until all roller marks are eliminated.
- c. No traffic shall be allowed on the surface being placed until rolling has been completed and the surface has cooled sufficiently to prevent damage from traffic.

3.6 NON-CONFORMING WORK

- A. If it is determined by the Engineer that the work is outside acceptable tolerances or to be non-conforming work per these specifications, the Contractor will be notified and allowed to make any necessary corrections to their operations. Should the Contractor fail to make the necessary corrections as requested, the Engineer will determine the best course of action to correct which could include reducing final payment or hiring outside forces, at the Contractor's expense, to correct. The Contractor shall submit to the Engineer for review the means and methods to make deficient areas compliant. Corrections shall be made based on these as directed by the Engineer.
- B. Non-Conforming Work - Identified during construction.
 1. Temperature: HMA shall be rejected per Section 3.5A. If the HMA is placed it shall be either removed or replaced or if acceptable to be left in place by the Contractor, a 25% reduction in payment will be assessed.
 2. Layer Thickness shall meet contract documents. Additional layers shall not be placed until resolved. Resolution may require removal and replacement, adjustments in placement of the next layer or grinding.
 3. Yield: Additional course shall not be placed until resolved.
 4. Joint Quality: If found to be deficient, the Contractor may be required to saw cut and seal the joint with hot poured rubber sealant or may be required to remove and replace the full width of pavement in the affected areas.
 5. Surface Texture (Segregation): Remove and replace to the full lane width in the affected area.
 6. Surface Smoothness: Remove and replace to the full lane width in the affected area.
 7. Density
 - a. Remove and replace to the full lane width in the affected area.
 - b. If in lower courses do not place additional courses until resolved
 8. Longitudinal Joint Density
 - a. Remove and replace to the full width of the pavement in the affected area.
 9. Mixture Properties: Test second sample, if obtained, for mixture. If second sample tests do not concur with first sample for the properties that are out of specification, no action is required. If second sample test results concur with first sample for the properties that are out of specification either remove and replace the affected HMA

or if acceptable to be left in place by the Contractor, a 25% reduction in payment will be assessed.

- C. Non-Conforming Work - Identified during the warranty period.
 - 1. Joint Quality: Saw cut and seal the joint with hot poured rubber sealant or remove and replace the full width of pavement in the affected areas.
 - 2. Surface Texture (Segregation): Remove and replace the full lane width in the affected area.
 - 3. Rutting and/or Flushing: Remove and replace the full lane width in the affected area.
 - 4. Cracks
 - a. For transverse cracks, either route and seal the crack with hot poured rubber sealant or remove and replace with a patch wide enough to accommodate the equipment needed to achieve the required density.
 - b. For random cracks remove and replace to the full lane width of the pavement in the affected area.
 - c. For edge cracks remove and replace to a width of at least three feet along the affected area

END OF SECTION

Table 1-1. Requirements for HMA Mixture Submittals

Job Name, HMA Supplier, and HMA Mixture Type

Plant No. and Plant Location

MDOT Form 1911 for plant with Traveling Mix Inspector signature and Plant Certification Date for current year.

Aggregate Pit No., Type and Blend %

Aggregate Gradation -Each and Combined

Aggregate Crushed %

Aggregate Soft Particle%

Aggregate Angularity Index

Aggregate L.A. Abrasion

Specific Gravity of Combined Aggregate, G_{sb}

Aggregate Wear Index

Binder Supplier and MDOT Certifier Number

Binder Virgin Grade and Final Grade

Binder Specific Gravity

% Binder from RAP

% New Binder Added

Mix Properties at Test Points 4 (minimum) and Optimum Binder Content

Binder Content, %

Bulk Specific Gravity, compacted

Theoretical Maximum Specific Gravity

Air Voids, %

Voids in Mineral Aggregate, % (VMA)

Voids Filled with Asphalt, % (VFA)

Stability (LBS)

Flow (.01 In)

Worksheets

Regression Analysis for Marshall Mix Design

Bulk Specific Gravity Worksheet – Marshall Specimens

Theoretical Maximum Specific Gravity Worksheet

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Table 1-1. Requirements for HMA Mixture Submittals – Superpave Mixtures

Job Name, HMA Supplier and HMA Mixture Type
Plant No. and Plant Location

Aggregate Pit No., Type and Blend %
Aggregate Gradation -each and combined
Fine Aggregate Angularity
Aggregate % Sand Equivalent
Aggregate L.A. Abrasion
Aggregate Soft Particle %
Aggregate % Flat and Elongated Particles
Specific Gravity of Combined Aggregate, G_{sb}
Aggregate Wear Index

Binder Supplier and MDOT Certifier Number
Binder Virgin Grade and Final Grade
Binder Specific Gravity
% Binder from RAP
% New Binder Added

Mix Properties at Test Points 4 (minimum), Optimum Binder Content, and Verification Test Results at N_{MAX}

Binder Content, %
Bulk Specific Gravity at N_{DES} and at N_{MAX}
Theoretical Maximum Specific Gravity
Air Voids % (VMA) at N_{DES}
Voids in Mineral Aggregate (VMA) @ N_{DES}
Voids Filled with Asphalt (VFA) @ N_{DES}
% G_{mm} @ N_{INT} , N_{DES} and N_{MAX}
Fines /EFF Asphalt Ratio

Worksheets

Regression Analysis for Superpave Mix Design
Bulk Specific Gravity – Gyrotory Specimens
Theoretical Maximum Specific Gravity
Coarse and Fine Aggregate Bulk Specific Gravity
Tensile Strength Ratio

Table 2-1. Master Gradation Ranges for Aggregate Blend for HMA Mixtures

HMA Mixture	2C	11A	3C	4C MOD	13A MOD	36A MOD
% Passing 1 1/2 inch	100	100				
% Passing 1 inch	91-100	90-100	100			
% Passing 3/4 inch	90 max	70-95	91-100	100	100	
% Passing 1/2 inch	78 max	55-85	90 max	91-100	75-95	100
% Passing 3/8 inch	70 max	40-80	77 max	90 max	60-90	92-100
% Passing No. 4	52 max	25-65	57 max	67 max	45-80	65-90
% Passing No. 8	15-40	15-50	15-45	15-52	30-65	55-75
% Passing No. 16	30 max	10-40	33 max	37 max	20-50	
% Passing No. 30	22 max	7-32	25 max	27 max	15-40	25-45
% Passing No. 50	17 max	5-20	19 max	20 max	10-25	
% Passing No. 100	15 max	4-12	15 max	15 max	5-15	
% Passing No. 200	3-6	3-6	3-6	3-6	3-6	3-10

Note: RAP for HMA Mixture 4C MOD is limited to 15% of the total mixture
RAP for HMA Mixtures 13A MOD and 36A MOD is limited to 15% of the total mixture when used for HMA top course (Section 2.2.D).

Table 2-1. Master Gradation Ranges for Aggregate Blend for HMA Mixtures

HMA Mixture	700B MOD	1100L MOD	1100T MOD	1300L MOD 1300T MOD	1500L MOD 1500T MOD
% Passing 1 1/2 inch	100				
% Passing 1 inch	80-100				
% Passing 3/4 inch		100	100	100	
% Passing 1/2 inch		90-100	90-100	90-100	100
% Passing 3/8 inch	55-90	65-95	65-95	65-95	92-100
% Passing No. 4				55-75	65-90
% Passing No. 8	30-55	45-70	45-70	45-70	55-75
% Passing No. 16					
% Passing No. 30	15-40	20-45	20-45	20-45	25-50
% Passing No. 50					
% Passing No. 100					
% Passing No. 200	3-10	3-10	3-10	3-10	4-10

Note: RAP for HMA Mixtures 1100T MOD, 1300T MOD and 1500T MOD is limited to 15% of the total mixture (Section 2.2.D).

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**Table 2-1. Master Gradation Ranges for Aggregate Blend for HMA Mixtures –
Superpave Mixtures**

HMA Superpave Mixture Number	5 MOD	4 MOD	3	2
Control Points				
% Passing 1 1/2 inch				100
% Passing 1 inch			100	90-100
% Passing 3/4 inch		100	90-100	90 max
% Passing 1/2 inch	100	90-100	90 max	
% Passing 3/8 inch	90-100	90 max		
% Passing No. 4	90 max			
% Passing No. 8	32-67	28-58	23-49	19-45
% Passing No. 16				
% Passing No. 30				
% Passing No. 50				
% Passing No. 100				
% Passing No. 200	2.0-10.0	2.0-10.0	2.0-8.0	1.0-7.0
Restricted Zone (a)				
% Passing No. 4				39.5
% Passing No. 8	47.2	39.1	34.6	26.8-30.8
% Passing No. 16	31.6-37.6	25.6-31.6	22.3-28.3	18.1-24.1
% Passing No. 30	23.5-27.5	19.1-23.1	16.7-20.7	13.6-17.6
% Passing No. 50	18.7	15.5	13.7	11.4

(a) The final gradation blend must pass between the control points established. The following conditions must be satisfied in order for the final gradation blend to enter the restricted zone:

- Mixture types E03, E1, E10, E30 and E50 may enter the restricted zone provided the final gradation blend enters from above the maximum density line.
- Mixture type E3 may enter the restricted zone provided the final gradation blend enters from above the maximum density line and the fine aggregate angularity of the final blend is a minimum of 43.

Notes: RAP for HMA Superpave Mixture Number 5 MOD is limited to 15% of the total mixture (Section 2.2.D).
RAP for HMA Superpave Mixture Number 4 MOD is limited to 15% of the total mixture when used for HMA top course (Section 2.2.D.).

Table 2-2. Physical Requirements for Aggregates for HMA mixtures

HMA Mixture	2C	11A	3C	4C MOD	13A MOD	36A MOD
Crushed, %, min, MTM 117	90	90	90	90	90	90
Soft Particle, %, max, MTM 110 (a)	12.0	12.0	12.0	8.0	12.0/8.0 (b)	8.0
Fine Aggregate Angularity, min, MTM 118 (c)	4.0	2.5	4.0	4.0	2.5	3.0
L.A. Abrasion, % loss, max, MTM 102, (d)	40	40	40	40	40	40
Sand Ratio, max (e)	-	-	-	-	50	50

- (a) Soft particles maximum is the sum of the shale, siltstone, friable sandstone, ochre, coal, clay-ironstone and any particles that are structurally weak or are non-durable in service.
- (b) When HMA mixture is used for HMA leveling or base course /HMA top course
- (c) The angularity index of the blended aggregate must meet the minimum requirement. In mixtures containing RAP, the required minimum angularity index must be met by the virgin material.
- (d) For the composite mixture. Each individual aggregate must be less than 50.
- (e) Percent of material passing the No. 4 sieve as a percent of the percent of material passing the No. 30 Sieve.

Note: RAP for HMA Mixture 4C MOD is limited to 15% of the total mixture

RAP for HMA Mixtures 13A MOD and 36A MOD is limited to 15% of the total mixture when used for HMA top course (Section 2.2.D).

Table 2-2. Physical Requirements for Aggregates for HMA mixtures

HMA Mixture	700B MOD	1100L MOD	1100T MOD	1300L MOD 1300T MOD	1500L MOD 1500T MOD
Crushed, %, min, MTM 117	25	40	90	90	90
Soft Particle, %, max, MTM 110 (a)	12.0	12.0/8.0 (b)	12.0/8.0 (b)	12.0/8.0 (b)	12.0/8.0 (b)
L.A. Abrasion, % loss, max, MTM 102 (c)	40	40	40	40	40

- (a) Soft particles maximum is the sum of the shale, siltstone, friable sandstone, ochre, coal, clay-ironstone and any particles that are structurally weak or are non-durable in service.
- (b) When HMA mixture is used for HMA base or leveling course /HMA top course
- (c) For the composite mixture. Each individual aggregate must be less than 50.

Note: RAP for HMA Mixtures 1100T MOD, 1300T MOD and 1500T MOD is limited to 15% of the total mixture (Section 2.2.D.)

Table 2-2. Physical Requirements for Aggregates for HMA mixtures – Superpave Mixtures

HMA Superpave Mixture Type (f)	Fine Aggregate Angularity, Min (a)		% Sand Equivalent, Min (b)		Los Angeles Abrasion % Loss Min, MTM 102		% Soft Particles Max, MTM 110 (d)		% Flat and Elongated Particles, Max (e)	
	Top and Level	Base	Top and Level	Base	Top and Level	Base	Top and Level	Base	Top and Level	Base
E03			40	40	45	45	10	10		
E1	40		40	40	40	45	10	10		
E3	40 (c)	40 (c)	40	40	35	40	5	5	10	10
E10	45	40	45	45	35	40	5	5	10	10
E30	45	40	45	45	35	35	3	4.5	10	10
E50	45	45	50	50	35	35	3	4.5	10	10

- (a) AASHTO T 304/ASTM C1252 Method A, test all materials including RAP which have material retained on the No. 16, No. 30, No. 50 and No. 100 sieves
- (b) ASTM D2419, test on all material including RAP
- (c) For an E3 Mix type that enters the restricted zone as defined in Table 2-1 the minimum is 43.
- (d) Soft particles maximum is the sum of the shale, siltstone, friable sandstone, ochre, coal, clay-ironstone and any particles that are structurally weak or are non-durable in service.
- (e) ASTM D 4791. Maximum by weight with a 1:5 aspect ratio.
- (f) RAP for HMA Superpave Mixtures is limited to 15% of the total mixture when used for HMA top course (See Section 2.2 D)

Table 2-3. Specifications for Performance Graded Binder

Binder Designation	PG 52-22	PG 58-22	PG 64-22	PG 70-22	PG 52-28	PG 58-28	PG 64-28	PG 58-34
Average 7-day Max. Pavement Design Temp, °C	52	58	64	70	52	58	64	58
Minimum Pavement Design Temp, °C	-22	-22	-22	-22	-28	-28	-28	-34
Original Binder								
Flash Point Temp, T48/D92 Min, °C	230	230	230	230	230	230	230	230
Viscosity, T316/D4402: Max 3 Pa•s, Test Temp, °C	135	135	135	135	135	135	135	135
Dynamic Shear, T315/D7175: G*/sin θ, Min 1.00 kPa, Test Temp, °C at 10 rad/s	52	58	64	70	52	58	64	58
Rolling Thin Film Oven (T240/D2872)								
Mass Loss, Max, %	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Dynamic Shear, T315/D7175: G*/sin θ, Min 2.20 kPa, Test Temp, °C at 10 rad/s	52	58	64	70	52	58	64	58
Pressure Aging Vessel Residue (R28/D6521)								
PAV Aging Temp, °C	90	100	100	100	90	100	100	100
Dynamic Shear, T315/D7175: G*/sin θ, Max 5000 kPa, Test Temp, °C at 10 rad/s	19	22	25	28	16	19	22	16
Physical Hardening (a)	Report	Report	Report	Report	Report	Report	Report	Report
Creep Stiffness T315/D6648 S Max, 300 MPa M-value, Min 0.300 Test Temp, °C at 60 s (b)	-12	-12	-12	-12	-18	-18	-18	-24
Direct Tension T314/D6723 Fail, Strain Min 1.0% Test Temp, °C at 1.0 mm/min	-12	-12	-12	-12	-18	-18	-18	-24

- (a) Physical hardening is performed on a set of asphalt beams except the conditioning time is extended to 24h ± 10 min at 10% C above the minimum performance temperature. The 24 h stiffness and m-value are reported for information purposes only
- (b) If the creep stiffness is below 300 MPa, the direct tension tests are not required. If the creep stiffness is from 300 MPa to 600 MPa, the direct tension failure strain requirement can be used in lieu of the creep stiffness requirement. The m- value requirement must be satisfied in both cases

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Table 2-4. Mix Design Criteria and Volumetric Properties

HMA Mixture	2C	11A	3C	4C MOD	13A MOD	36A MOD
Target Air Void, %	3.00	3.00	4.00	4.00	4.00/3.00 (a)	4.00/3.00 (a)
VMA, min, (based on G _{sb})	11.00	11.00	13.00	14.00	14.00	15.00
VFA	65-78	65-78	65-78	65-78	65-78	65-78
Fines to Binder Ratio, max (b)	1.2	1.2	1.2	1.2	1.2	1.2
Flow (.001 inch)	8-16	8-16	8-16	8-16	8-16	8-16
Stability, lbs, min	1200	1200	1200	1200	1200	1200

- (a) Target Air Void may be reduced to 3.00% for low volume roads for HMA mixture 13A and 36A if designated in the contract documents.
- (b) Ratio of aggregate passing the No. 200 sieve to total asphalt binder content by weight including fines and binder content contributed by RAP

Note: RAP for HMA Mixture 4C MOD is limited to 15% of the total mixture
RAP for HMA Mixtures 13A MOD and 36A MOD is limited to 15% of the total mixture when used for HMA top course (Section 2.2.D).

Table 2-4. Mix Design Criteria and Volumetric Properties

HMA Mixture	700B MOD	1100L MOD	1100T MOD	1300L MOD 1300T MOD	1500L MOD 1500T MOD
Target Air Void, %	4.00	3.00	3.00	3.00	3.00
VMA, min (based on G _{sb})	13.00	13.50	13.50	14.00	14.00
VFA	65-78	65-78	65-78	65-78	65-78
Fines to Binder Ratio, max (a)	1.2	1.2	1.2	1.2	1.2
Flow (.001 inch)	8-16	8-16	8-16	8-16	8-16
Stability, lbs, min	700	1100	1100	1300	1500

- (a) Ratio of aggregate passing the No. 200 sieve to total asphalt binder content by weight including fines and binder content contributed by RAP

Notes:
Measure and/or calculate volumetric properties from specimens made using a 50 blow Marshall Hammer per the Asphalt Institute Manual MS-2.
Measure the density of the Marshall specimens per ASTM D 2726.
Measure the Maximum Specific Gravity per ASTM D 6857.
Measure Flow and Stability of Marshall specimens per ASTM D 5581.
RAP is limited to 15% of the total mixture for HMA Mixtures 1100T MOD, 1300T MOD and 1500T MOD (Section 2.2.D).

Table 2-4. Mix Design Criteria and Volumetric Properties – Superpave mixtures

HMA Superpave Mixture Number	5 MOD	4 MOD	3	2
% G _{mm} at the design Number of Gyration (N _d) (a)	96.0			
% G _{mm} at the initial Number of Gyration (N _i)	See Table below			
% G _{mm} at the maximum number of Gyration (N _m)	98.0			
VMA Min % at N _d (based on G _{sb})	See Table below (b)			
VFA at N _d	15.00	14.00	13.00	12.00
Fines to effective asphalt binder ratio (P _{n200} /P _{bc})	0.6 to 1.2			
Tensile Strength ratio (TSR)	80% min			

(a) For HMA Base Course mixtures, design mixtures to 96.0% of % G_{mm} at N_d. During field production increase the % G_{mm} at N_d to 97.0%

(b) For HMA Base Course mixtures, the maximum criteria limits do not apply.

Notes: RAP for HMA Superpave Mixture Number 5 MOD is limited to 15% of the total mixture (Section 2.2.D).
RAP for HMA Superpave Mixture Number 4 MOD is limited to 15% of the total mixture when used for HMA top course (Section 2.2.D.).

HMA Superpave Mixture Type (a)	% G _{mm} at N _i	N _i	N _d	N _m	VFA Min-Max Top and Level	VFA Min-Max Base
E03	91.5%	7	50	75	70-80	70-80
E1	90.5%	7	76	117	65-78	65-78
E3	90.5%	7	86	134	65-78	65-78
E10	89.0%	8	96	152	65-78 (b)	65-75
E30	89.0%	8	109	174	65-78 (b)	65-75
E50	89.0%	9	126	204	65-78 (b)	65-75

(a) Mixes used for HMA top course are limited to 15% of the total mixture (See Section 2.2 D)

(b) 73 to 76% for Mix Number 5

Notes:

Measure and/or calculate volumetric properties from specimens made using a Gyratory Compactor per the MDOT HMA Production Manual existing at the time of the contract award.

Measure the density of the Gyratory Compactor specimens per ASTM D 2726.

Measure the Maximum Specific Gravity per ASTM D 6857.

Table 3-1. HMA Mixture Placement Temperatures

Temperature of Surface Being Overlaid, Deg F	Layer Thickness		
	1 inch and under	1 inch to 2 inches	Over 2 inches
	Target Placement Temperature Deg F		
35-39			310 - 350
40-49		310 - 350	295 - 335
50-59	310 - 350	295 - 335	280 - 320
60-69	295 - 335	280 - 320	265 - 305
70-79	280 - 320	265 - 305	250 - 290
80-89	265 - 305	250 - 290	250 - 290
90 and over	250 - 290	250 - 290	250 - 290

Air temperature must be 40 deg F and rising for the placement of HMA.

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Table 3-2. Roller Type Application Chart

Roller Type	HMA base course	HMA leveling course	HMA top course	Pinching Joints
Pneumatic-tired	Initial Compaction only	Initial Compaction only	No	No
Tandem Steel Wheeled – Vibratory mode	Initial Compaction only	Initial Compaction only	Initial Compaction only	No
Tandem Steel Wheeled – Static mode	Initial and/or Final Compaction	Initial and/or Final Compaction	Initial and/or Final Compaction	Initial and/or Final Compaction

Table 3-3. Uniformity Tolerance Limits for Aggregate Blends

Parameter	Top and Leveling Courses	Base Course
% Passing # 8 and Larger Sieves	± 8.0	± 9.0
% Passing # 30 sieves	± 6.0	± 9.0
% Passing #200 Sieve	± 2.0	± 3.0

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SECTION 02669

BURIED PROCESS PIPE AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY OF WORK

- A. Covers all pipe, fittings and appurtenances installed in buried conditions and used for process services.
- B. Furnish all labor, materials, tools, equipment, and supervision required to complete all piping systems, as indicated on the drawings and specified herein, and all other work incidental thereto, except as otherwise noted.

1.2 Related Work

- 1. Section 01300 – Submittals
- 2. Section 02315 – Utility Trenching, Backfill and Compaction
- 3. Section 15000 – Equipment General
- 4. Section 15060 – Exposed Process Pipe
- 5. Section 15100 – Valves

1.3 REFERENCES

- A. All materials and workmanship shall be in conformance with the following:
 - 1. Standards and Standard Methods published by the American Water Works Association (AWWA).
 - 2. Any and all Federal, State, and/or local codes, ordinances, or regulations.

1.4 SUBMITTALS

- A. Shop drawings are required for each item in this section of the specifications, including, but not limited to piping, couplings, gaskets, fittings, layouts, dimensions, etc. in accordance with Division 1.
- B. Manufacturer's Certificate: The manufacturer shall furnish a sworn statement that the inspection and all specified tests have been made, and that the results comply with the requirements of the listed standards.
- C. Contractor's Field Reports: Certify that installed products meet or exceed specified requirements.

1.5 DELIVERY STORAGE AND PROTECTION

- A. Properly store and protect all pipe per manufacturer recommendations.

1.6 REGULATORY REQUIREMENTS

- A. All piping materials, layout, and installation shall meet the requirements of governing local, state, and national codes. Referenced codes and standards herein shall be the current code or standard in effect at the time proposals are received.

1.7 WARRANTY

- A. The piping shall be guaranteed for a period of one year from the date of substantial completion.

1.8 REFERENCE STANDARDS

- A. NSF International (NSF)
 - 1. NSF 61: Drinking Water System Components
- B. American Water Works Association (AWWA)
 - 1. Various references as noted

PART 2 PRODUCTS

2.1 GENERAL

- A. For drinking water service provide NSF 61 certified pipe fittings and valves

2.2 DUCTILE IRON PIPE

- A. Pipe
 - 1. Comply with AWWA C151
 - 2. Dimensions and thickness of ductile-iron pipe will be based on the Special Thickness Class as listed in ANSI/AWWA C150, meeting the following minimum requirements:

Size (Nominal Inside Dia. Inches)	Outside Dia. (Inches)	Thickness (Inches)	Special Thickness Class
6	6.90	0.37	54
8	9.05	0.39	54
12	13.20	0.43	54
16	17.40	0.46	54
20	21.60	0.51	55
24	25.80	0.56	56
30	32.00	0.63	56

- B. Joints
 - 1. Push-on Joints
 - a. Manufactured in accordance with AWWA C111,

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- b. Provide the following:
 - 1) Super Bell Tite by Clow,
 - 2) Fastite by American Cast Iron pipe,
 - 3) Tyton by US Pipe, or
 - 4) Approved equal.
- 2. Mechanical Joints
 - a. Manufactured in accordance with AWWA C111,
- 3. Restrained Joints
 - a. Retrain joints on all fittings and valves
 - b. Provide thrust restraints on all couplings within the specified distance from valves and fittings as shown in the thrust restraint schedule in the Contract Drawings.
 - c. Provide thrust restraint using the following:
 - 1) Mechanical restraint joint couplings: EBAA Series 1100 Mega-Lug or approved equal
 - 2) Locking gaskets: Fast-Grip by American Cast Iron Pipe Company, Field-Lok by US Pipe, or approved equal
- 4. Grooved Pipe Couplings
 - a. Install only where called out on the plans
 - b. Provide coal tar epoxy coating on all couplings and fittings
 - c. Couplings
 - 1) Victaulic Style 31 or engineer approved equal
 - 2) Grooves cut for rigid joints.
 - 3) For potable water service and hot water service provide halogenated butyl gaskets (Victaulic grade M)
 - 4) For all other applications provide nitrile gaskets (Victaulic grade S)
 - d. Fittings
 - 1) Victaulic with rigid grooves
 - 2) Conform to ANSI/AWWA C-606.
 - e. Couplings shall engage the grooved pipe around the entire circumference, and bolt together with two or more track head bolts.
 - f. Bolts and nuts shall be
 - 1) General service: fluoropolymer topcoat over cadmium or zinc plating
 - 2) Wet well or corrosive service: 316 SS.
- C. Gaskets
 - 1. Supplied by the pipe manufacturer,
 - 2. Conform to all requirements of AWWA C111.
 - 3. Styrene Butadiene Rubber (SBR)
- D. Fittings
 - 1. Gray-iron and/or ductile-iron conforming with AWWA C110
 - 2. For compact fittings, conform to AWWA C153
 - 3. Cast the manufacturer's mark, nominal diameter of openings, type of fitting, and pressure rating on the fitting.
- E. The pressure rating of pipe joints shall meet the minimum requirements as listed in ANSI/AWWA C111.
- F. Hardware
 - 1. Low alloy steel compliant with AWWA C111

2. Coated with a minimum two (2) coats of fluoropolymer epoxy coating and heat cured.
3. Manufacturers:
 - a. Cor-Blue by Birmingham Fasteners
 - b. R-Blue by Romac Industries
 - c. Owner approved equal

G. Lining

1. Cement lining in accordance with AWWA C104
2. Required for all pipe and fittings.
3. Provide double thickness lining.

H. Polyethylene Encasement

1. Required for all pipe and fittings
2. Polyethylene encasement in accordance with AWWA C105
3. Install following Method "A"

2.3 GRAVITY SEWER FOR PROCESS SERVICE

A. 12" and smaller

1. SDR 26 PVC plastic sewer main (PSM), conforming to ASTM D3034
2. Minimum pressure rating: 160-PSI
3. Push on joints, conforming to ASTM D3212
4. Elastomeric ring gaskets suitable for environment and compatible with substance being conveyed
5. Provide pipe with legible markings at intervals of no more than 5-feet with the following:
 - a. Nominal pipe size
 - b. PVC cell classification or material code
 - c. Dimension Ratio (DR)
 - d. AWWA pressure class
 - e. Hydrostatic integrity test pressure
 - f. AWWA standard designation number (C900)
 - g. Manufacturer's name and trademark and production run record or lot code
 - h. Maximum allowable axial joint deflection in degrees (for pipes with deflectable joints)
 - i. Pipe not marked as indicated above will be rejected.

B. Larger than 12"

1. Reinforced Concrete Pipe complying with ASTM C-76
2. Modified groove tongue joint with approved rubber gasket, ASTM C-443

2.4 STEEL PIPE FOR HIGH PRESSURE SEWAGE

A. Pipe 4-Inch Diameter and Larger:

1. Seamless steel ASTM A106 Grades A, ASA B31.1. with Schedule 80 thickness.

B. Pipe Joint Interior:

1. Welded, ANSI flanged or grooved coupling in accordance with AWWA C606 (Victaulic Style 07) and shall be rated for 600 psi.
- 2.

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3. Rigid, capable of transmitting both tensile and compressive load.
- C. Pipe Joint Exterior/Buried Joints.
1. Shop welded joints per American Welding Society standards, field welded per AWWA C206.
 2. Re-coat field welded pipe as required
 3. Grooved couplings with Victaulic Style 77 flexible coupling where noted on the DRAWINGS at a minimum.
 4. At Contractor's option, all buried joints can be grooved coupling.
- D. Coat interior of pipes as follows:
1. Surface Prep: SSPC-SP6
 2. Prime: Tnemec Series N69 3.0 – 5.0 mils
 3. Intermediate: Tnemec Series N69 4.0 – 6.0 mils
 4. Finish: Tnemec Series 1075 Endura Shield 2.0 – 3.0 mils
- E. Fittings:
1. Seamless steel welded ASA B16.9.
 2. Coat in accordance with pipe coating requirements.
- F. Gaskets:
1. For flanged joints: 1/8-inch-thick, Neoprene rubber.

2.5 COPPER PIPING

- A. Clear water piping smaller than 4" in diameter
1. Piping: Type "K" light drawn or annealed, seamless, copper tubing, conforming to ASTM B88.
 2. Fittings shall be flared or compression, conforming to ANSI B16.26.

2.6 DOUBLE WALL PVC PIPING (DW PVC) FOR CHEMICAL SERVICE

- A. Product Pipe and Containment Pipe shall be
1. Schedule 40 PVC with Iron Pipe Size dimensions conforming to ASTM D-1785
 2. Maximum water pressure rating of 250 PSI @ 75° F
 3. Cell classification of 12454-B conforming to ASTM D-1784
 4. All pipe shall be listed to NSF Standard 61 or health effects portion of NSF Standard 14.
- B. All pipe shall be factory aligned and supported, within the containment casing, with
1. Pipe supports constructed of the same resin as product pipe and designed to allow free air and fluid movement within the containment pipe.
 2. The supports will be designed and spaced to carry the weight of the product pipe full of fluid while allowing the carrier pipe to expand and contract.
 3. Supports shall maintain a concentric relationship between the product pipe and containment pipe.
- C. Fittings:
1. Fabricated in accordance with ASTM D-2467.
 2. Maximum water pressure rating equal to Product and Containment Pipe

- D. Field joints and installation
 - 1. All joining shall be done using a 2-step process of primer and cement in accordance with ASTM D 2564.
 - 2. Hot gas welding shall not be allowed for wetted components.
 - 3. Install double containment piping to comply with manufacturer's recommended procedures.
 - 4. Provide Weld-On 724 solvent cement and Weld-On P-70 Primer as manufactured by IPS Corporation for all pipe joints.
- E. Testing and certification procedures
 - 1. Demonstrate that containment pipe, product pipe, fittings and end seals can pass a 100-psi hydro pressure test. Containment pipe can only be tested once product pipe is at same anticipated containment pipe pressure to prevent product pipe collapse. Alternate air pressure testing at 5 psi may be conducted on containment pipe to prevent trapping water during testing.
 - 2. Provide test certification by an Independent Testing Agency.
- F. The pre-fabricator will provide a field service instructor on site to train the contractor in all phases of installation and operation of double-containment system.
- G. Warranty
 - 1. Warranty period shall be one year after product has been put into service.
- H. Products
 - 1. Asahi Pro-Lock PVC Double Containment Piping System or equal.

2.7 MEDIUM DENSITY POLYETHYLENE PIPE (MDPE)

- A. Medium density polyethylene pipe and fittings shall be PE 2406 meeting cell classification 234363E per ASTM D3350, with resins listed in the Plastic Pipe Institute TR-4, and shall have a Hydrostatic Design Basis (HDB) of 1,250 psi at 73.4°F. The pipe and fittings shall be manufactured and tested in accordance with ASTM D2513.
- B. All pipe materials shall be yellow and stabilized against ultraviolet deterioration.
- C. Socket type fittings shall comply with ASTM D2683. Butt fusion fittings shall comply with ASTM D3261. Electrofusion fittings shall comply with ASTM F1055. Mechanical fittings shall be categorized for pullout resistance per ASTM D2513 and identified as to the appropriate category.
- D. When joining pipe using heat fusion, the same manufacturer shall supply the polyethylene pipe and heat fusion fittings. Pipe and fusion fittings from different manufacturers shall not be interchanged.

2.8 PVC DRAIN PIPE (PVC-D)

- A. Plastic pipe for footing drains
 - 1. Polyvinyl chloride (PVC) pipe meeting the requirements of AASHTO M 278.

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2. As an option, acrylonitrile-butadiene-styrene (ABS) pipe meeting the requirements of ASTM D 2751, SRD 35, with perforations meeting the requirements of AASHTO M 278, may be furnished.

2.9 HDPE PIPING

- A. Pipe:
 1. For pipe size 4" and larger
 - a. Comply with ASTM D3035 and AWWA C906
 - b. DIPS DR 11 (Pressure Class 200 psi), at a minimum
 2. For pipe smaller than 4:
 - a. Comply with ASTM D3035 and AWWA C901
 - b. Provide CTS DR9 for the nominal diameter, at a minimum
- B. HDPE pipe will be produced from resins that meet or exceed the requirement of ASTM D3350, designation PE4710, that meets or exceeds a cell classification of PE445574C/E per ASTM D3350.
 1. Material taken from HDPE pipe will meet the minimum stability requirement of ASTM D3350.
 2. Material compound shall have a hydrostatic design stress (HDS) rating for water at 73 degrees F of not less than 1000 psi that shall be listed in PPI TR-4 in the name of the pipe manufacturer.
 3. Material compound shall have a hydrostatic design basis (HDB) rating for water at 140 degrees F of not less than 1000 psi that shall be listed in PPI TR-4 in the name of the pipe manufacturer.
 4. Pipe and fittings shall contain a UV stabilizer to protect the pipe against UV degradation for at least 24 months of unprotected outdoor exposure.
 5. HDPE resin manufacturer to certify the cell classification.
- C. Permanently mark pipe with using heated indent printing at intervals of no more than five (5) feet with the following:
 1. Nominal pipe size and sizing system
 2. Dimension Ratio
 3. ASTM testing designation
 4. HDPE cell classification
 5. Pressure rating or pressure class at 73 degrees F
 6. NSF-61 approved (potable water piping only)
 7. Date of manufacture
 8. Point of origin
 9. Manufacturer's name and trademark,
 10. Example (8" DIPS DR 11, ASTM D3035 PE445574C/E PR200 NSF-61,
- D. Pipe and butt fusion fittings shall have plain ends for butt-fusion.
- E. Fittings shall be manufactured from the PE4710 resin in accordance with these specifications and may be molded, thermoformed from pipe sections, or fabricated by heat fusion joining HDPE components prepared from pipes, molded fittings, thermoformed pipe or polyethylene sheet or block meeting the requirements of AWWA C901 or AWWA C906.
 1. Molded fittings shall comply with ASTM D3261 for butt and saddle type fusion fittings, flange adapters and MJ adapters.
 2. Fabricated fittings shall comply with ASTM F2206.

- a. Provide test results to validate compliance with Section 7.3 and Section 9.
 3. Socket fittings shall comply with ASTM D2683
 4. Markings on fittings shall comply with the requirements of ASTM D3261 and ASTM F2206.
 5. Fittings shall have pressure class ratings not less than the pressure class rating of the pipe to which they are joined.
- F. MJ Adapters and Flange Adapters
1. Fittings described in this section include all fittings intended to be joined to HDPE piping by thermal heat fusion that have one or more parts for effecting a mechanical connection, such as mechanical-joint (MJ) or flange, to ductile iron or other type of piping.
 2. Fittings will be produced from resins that meet or exceed the requirements of ASTM D3350, designation PE4710 and specifically made for use on municipal water systems.
 3. Backup rings, flanges or glands shall be made of stainless steel or suitably coated steel or ductile iron.
 - a. MJ glands shall conform to AWWA C111.
 - b. All flange dimensions, except thickness, shall conform to AWWA C207 to ensure they mate with other inline components.
 - c. Support provided thickness with calculations made by the backup ring supplier for the specified pressure rating, and provide upon request.
 - d. Pressure ratings provided in AWWA C207 do not apply to HDPE piping systems.
 4. Rubber gaskets shall be made of vulcanized styrene butadiene rubber (SBR), meeting the requirements of AWWA C111.
 5. Each fitting shall be designed and manufactured to operate at not less than the Pressure Class of the pipe system for which it is intended.
- G. Electrofusion Couplings and Fittings
1. Fittings described in this section include all couplings and fittings intended to be joined to HDPE piping by electrofusion means.
 2. Electrofusion fittings will be produced from resins that meet or exceed the requirements of ASTM D3350, designation PE4710, and specifically made for use on municipal water systems.
 3. Electrofusion-type molded fittings shall meet the requirements of ASTM D2683 for socket-type fittings and ASTM F1055.
 4. Markings on fittings shall comply with the requirements of ASTM F1055
 5. Each fitting shall be designed and manufactured to operate at not less than the Pressure Class of the pipe system for which it is intended.
 6. All electro-fusion fittings shall have AWWA approval.
- H. Tracer Wire
1. Use tracer wire made of solid or multi-strand copper, copper-clad steel, or stainless steel encased within an HDPE jacket with a 45-mil minimum thickness. Jacket color shall be blue per APWA color coding convention. Tracer wire shall have a minimum tensile strength/break load of 2,500 pounds and shall be specifically designed for horizontal directional drilling applications.
 2. Provide manufactured connectors that are rated for direct burial, have a dielectric gel and are sealed.

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3. Provide test stations that are compatible with Owner's locating equipment. For test stations not located within a gate well, provide a heavy-duty tracer box with cast iron cover. Tracer boxes in pavement shall be flush-mounted and rated for traffic.
4. Provide magnesium anodes for grounding all dead ends of tracer wire not brought to a test station.

PART 3 EXECUTION

3.1 GENERAL

- A. All pipe and fittings delivered to the Project shall be accompanied by documentation that the pipe and fittings meet the applicable specifications.
- B. Provide the necessary material and labor to make connections to existing piping when called for on the Drawings. Provide all necessary gaskets, bolts and fittings for this purpose.
- C. Pipe shall be kept clean. During construction, openings in pipe shall be fitted with temporary plugs except where the pipe is actually being worked on. Piping must be clean at time of final acceptance of the work.
- D. Where necessary to cut pipe, cutting shall be done with approved tools and cut ends of pipe shall be square and regular. Cutting shall be done in a manner to avoid damage to lining and coating.
- E. To prevent trench water from entering the pipe, joints which for any reason may not be completed as the pipe is laid shall be thoroughly packed with approved material, in a manner to make them watertight. Open ends of fittings shall be tightly closed with approved plugs and well packed as shall the end of the last pipe laid whenever work is not in progress.
- F. Tools or other objects shall not be stored or left in the pipe.

3.2 EXCAVATION

- A. The Contractor shall do all the excavation required for the construction of the mains and appurtenances, including clearing of the site of the work and the removal and disposal of all materials necessary to be removed in the construction of all work under this contract.
- B. Excavation shall be of sufficient widths and depths to provide adequate room for the construction and installation of the work to the lines, grades, and dimensions called for on the plans and to allow the backfill to be placed and compacted properly. Excavation shall be to depths which will provide a minimum cover of five (5) feet over the top of pipe to plan grade, unless otherwise noted on the Plans.
- C. Excavated materials may be temporarily stored along the trench, unless otherwise noted, in a manner that will not cause damage to trees, shrubs, fences, or other property, nor that will endanger the bank of the trench by imposing too great a load thereon.
- D. Excavations shall be adequately braced and/ or sheeted to prevent caving or squeezing of the soil, or disturbing existing utilities or pavement and shall be completely dewatered prior to construction of the piping system or other structures.

- E. Where, through the Contractor's construction procedure, or because of poor existing ground conditions, it is impossible to maintain alignment and grade properly, or provide suitable support for the pipe, the contractor shall, at his own expense, excavate below grade and replace with suitable approved material in order to insure that the pipe, when laid, will maintain correct alignment and grade.
- F. The subgrade shall be accurately prepared to line and grade so that the pipe, when laid, shall have uniform bearing upon the approved backfill, throughout its length.
- G. Pavement cutting, maintenance and restoration shall be done in a manner satisfactory to the Owner, and in accordance with other requirements of these Specifications.

3.3 PREPARATION OF TRENCH BOTTOM

- A. The bottom of trench shall be excavated neatly to the required grade prior to filling with minimum of four (4) inches of MDOT Class II sand thoroughly compacted by tamping before the pipe is laid. Blocking under pipe is strictly prohibited.

3.4 BACKFILLING

- A. After the pipe is laid, MDOT Class II sand backfill shall be thoroughly compacted in place to a level a minimum of four (4) inches above the top of the pipe. Particular care shall be taken to assure filling all spaces under, around and above the top of the pipe.
- B. The balance of the backfill shall be completed as shown on the Drawings for each specific area of work.

3.5 DUCTILE IRON PIPE

- A. Pipe shall be installed in accordance with the current AWWA C600, "Standard for Installation of Ductile Iron Water Mains and their Appurtenances."
- B. Before lowering into the trench, and while suspended, each pipe and fitting shall be inspected for defects and rung with a light hammer to detect cracks. Defective, damaged or unsound pipe shall immediately be removed from the construction site. The interior of each pipe shall be inspected for cleanness and cleared of all dirt and foreign matter before being lowered into the trench.
- C. Unless otherwise approved, pipe shall be laid with bell ends facing in the direction of laying. After a length of pipe is placed in the trench, the spigot shall be centered in the bell of the adjacent pipe, the pipe shoved into position and brought to true alignment and there secured with sand tamped under and on each side of the pipe, excepting at bell holes. No earth or other foreign matter shall be allowed to enter the joint space.
- D. When the temperature is above 60 degrees F., the spigot of each pipe laid shall be brought tightly home in the bell of the preceding pipe. When the temperature is below 60 degrees F., the pipe shall be laid with the spigot end approximately 1/16" from the face of the bell to allow for expansion.

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- E. Whenever deflections at joints are required by changes in grade or alignment, or to plumb valve stems, the deflection at any bell and spigot joint shall not exceed that which will cause the spigot end of pipe to be away from home in the bell of the adjacent pipe a distance of 1/4 inch at the point of greatest opening. The deflection at any mechanical joint shall not exceed three-quarters of the maximum deflection recommended by the manufacturer of the joint used.

3.6 PVC PIPE

- A. Assemble connections in gasketed-jointed PVC pressure pipe with mechanical fittings to provide a leak free system.
 - 1. Threaded or solvent-cement joints and connections are not permitted.
 - 2. All equipment and procedures used shall be used in strict compliance with the manufacturer's recommendations.
- B. Pipe joining by use of mechanical fittings, clamps, couplings, and mechanical joint restraint systems shall be completed considering the following:
 - 1. All mechanical fittings shall be designed for use with PVC pressure pipe, and rated for operating pressures equal to or greater than that of the piping system being installed.
 - 2. Gap between pipe ends shall not exceed 1/2 inch within mechanical couplings and clamps.
 - 3. Install gaskets in accordance with fitting manufacturer's procedures.
 - 4. Tighten bolts in accordance with fitting manufacturer's procedures.
 - 5. Certain mechanical fittings are not designed to restrain the pipe at all, or are not designed to restrain for all forces, such as thermal contraction/expansion and hydraulic thrust.
 - a. Additional restrained fittings must be installed or other measures taken, such as installation of concrete thrust blocks, cement stabilized backfill or inline pipe restraint, to restrain the pipe from movement due to all forces.
 - 6. The installation of mechanical joint restraint systems does not relieve the Contractor of installing thrust blocks as specified unless otherwise indicated.
 - 7. The completed joint shall be watertight and fully restrained.
 - 8. All defective joints shall be disassembled and replaced or reinstalled at no cost to the Owner.

3.7 HDPE PIPE

- A. The polyethylene pipe and fittings shall be assembled and joined at the site by heat fusion, manufactured transitions or adapters, or mechanical fittings to provide a leak-free system.
 - 1. Threaded or solvent-cement joints and connections are not permitted.
 - 2. All equipment and procedures used shall be used in strict compliance with the manufacturer's recommendations.
- B. Pipe joining by heat fusion methods shall be accomplished by personnel certified as fusion technicians by a manufacturer of polyethylene pipe and/or fusing equipment for each type of fusion being performed.
- C. During inclement weather, construct a temporary shelter around the joining operation to shield from rain, frozen precipitation, and high winds. During cold weather, area may need to be heated to assure proper fusion.
- D. Pipe joining by butt fusion shall be completed considering the following:

1. Use a fusion machine capable of aligning pipe ends, clamping the pipe, facing the pipe ends parallel and square to the centerline, heating the pipe ends, and applying the proper fusion force.
 2. Joints shall be true alignments and have uniform roll-back beads resulting from the use of proper temperature and pressure. The joint shall be allowed adequate cooling time before removal of pressure.
 3. Maintain a log of every fused joint, including a record of the fusion operator name, date, time, joint identification number, ambient temperature and weather conditions, equipment heating temperature, force or pressure applied, and cooling time.
 4. The fused joint shall be watertight and have tensile strength equal to that of the pipe, and be free of visual defects such as blisters or inclusion of foreign material. All defective joints shall be cut out and replaced at no cost to the Owner.
 5. Provide samples of fused joints at the request of the Owner.
 6. All joints shall be subject to acceptance by the Engineer prior to insertion.
- E. Pipe joining by electrofusion shall be completed considering the following:
1. Prepare the pipe by scraping and cleaning in accordance with the electrofusion fitting manufacturer's recommended procedures. Use tools specifically designed for this purpose.
 2. Wipe area of pipe being joined with 90% isopropyl alcohol.
 3. Align and restrain pipe being joined per manufacturer's procedures.
 4. Cut and face ends of pipe being joined so they are properly located between heating elements of the fitting.
 5. Apply electric current as required by manufacturer's procedures.
 6. Allow pieces to cool sufficiently before removing any clamps or restraints per manufacturer's procedures.
 7. Maintain a log of every fused joint, including a record of the fusion operator name, date, time, fitting location, ambient temperature and weather conditions, current applied, equipment heating temperature, and cooling time.
 8. The fused joint shall be watertight and have tensile strength equal to that of the pipe. All defective joints shall be cut out and replaced at no cost to the Owner.
 9. All joints shall be subject to acceptance by the Engineer prior to insertion.
- F. Pipe joining by use of manufactured adapters or transitions shall be completed considering the following:
1. Manufactured adapter or transition shall be fused to the pipe end by butt fusion or electrofusion coupling, completed as described in Part 3.5.D and 3.5.E, respectively.
 2. Install gaskets in accordance with fitting manufacturer's procedures.
 3. Tighten bolts in accordance with fitting manufacturer's procedures.
 4. The completed joint shall be watertight and fully restrained. All defective joints shall be disassembled and replaced or reinstalled at no cost to the Owner.
- G. Pipe joining by use of mechanical fittings, clamps, couplings, and mechanical joint restraint systems shall be completed considering the following:
1. All mechanical fittings shall be designed for use with HDPE pressure pipe, and rated for operating pressures equal to or greater than that of the piping system being installed.
 2. Internal pipe stiffeners must be used for HDPE pipe being joined with mechanical fittings, couplings, and mechanical joint restraint systems.

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3. Where terminal sections pipe are joined within an insertion shaft using a full circle pipe repair clamp, the gap between pipe ends shall not exceed 1/2-inch.
 4. Install gaskets in accordance with fitting manufacturer's procedures.
 5. Tighten bolts in accordance with fitting manufacturer's procedures.
 6. Certain mechanical fittings are not designed to restrain the pipe at all, or are not designed to restrain for all forces, such as thermal contractor/expansion and hydraulic thrust. Additional restrained fittings must be installed or other measures taken, such as installation of concrete thrust blocks, cement stabilized backfill or inline pipe restraint, to restrain the pipe from movement due to all forces.
 7. The completed joint shall be watertight and fully restrained. All defective joints shall be disassembled and replaced or reinstalled at no cost to the Owner.
- H. Terminal Restrained joints shall be used on all ductile iron pipe segments, fittings, hydrants and gate valves, and shall be installed in accordance with Section 02660 and 02661 of the Specifications. Install thrust blocks at hydrants and fittings where required by the Owner.
- I. When making a connection to an unrestrained part of the piping system, whether the existing mains at the limits of the project or within the new pipe system, install inline pipe restraint measures to prevent unrestrained joints from pulling apart. Methods for inline pipe restraint may include one or more of the following:
1. Installation of flex restraint fittings and concrete collar per detail in Plans. Allow for an adequate period of time for concrete curing before pressurizing the main.
 2. Excavation of an appropriate number of unrestrained joints on existing system and installation of restraint harnesses. Provide an analysis by a registered professional engineer, licensed in the State of Michigan, calculating the design thrust force and the required length of restrained pipe required to resist it. Backfill and restore disturbed surfaces.

3.8 FIELD QUALITY CONTROL

- A. General
1. When a section of pipe and appurtenances has been completed and bedding material is in place, provide the appliances, facilities, and water required for performing the specified pressure and leakage tests.
 2. After testing is complete, drain the pipeline without injury to the work or surrounding area.

3.9 HYDROSTATIC TEST

- A. Procedure
1. All pressure pipe shall be tested to the pressure given in the pipe schedule. All tests will be made by the Contractor using his own equipment, operators, and supervision, in the presence of the Owner or his duly authorized representative. The length of the section to be tested shall be as approved by the Owner, or as shown on the plans. The test shall not be against an existing valve, unless written permission is obtained from the water system operator. In no case shall a test be made against an existing valve that is found to be leaking or otherwise defective.
 2. Testing shall be in accordance with AWWA C600.

- B. Air Removal Before Test

1. Before applying the specified test pressure, all air shall be expelled from the pipe. If permanent air vents are not located at all high points, the Contractor shall install corporation cocks at such points so the air can be expelled as the line is filled with water. After all the air has been expelled, the corporation cocks shall be closed and the test pressure applied.

C. Leakage Test

1. A leakage test shall be conducted in the presence of the Owner's representative after the pressure test has been satisfactorily completed. The contractor shall furnish the pump, pipe, connections, gages and all other necessary apparatus, and shall furnish the necessary assistance to conduct the test. The duration of the test shall be 2 hours, and during the test the main shall be subjected to a pressure as given on the pipe schedule or 1-1/2 time working pressure.
2. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof, to maintain the specified leakage test pressure after the air in the pipeline has been expelled, and the pipe has been filled with water. No piping will be accepted until the total leakage measured over the quantity of pipe installed is below the testing allowance per the formula:

$$L = \frac{S * D * \sqrt{P}}{148,000}$$

L = allowable leakage in gallons per hour

S = length of pipe tested in feet

D = nominal diameter of the pipe in inches

P = average test pressure during the test, in psi (gauge)

* For pipes tested with varying diameter sections, the allowable leakage rate shall be the sum of the computed leakage for each section of pipe diameter

3. The Owner shall be furnished a written report of the results of the leakage test that identifies the specific length of pipe tested, the pressure, the duration of the test, and the amount of leakage. The report shall be signed by the Contractor and the Engineer.

D. Variation from Permissible Leakage

1. Should any test of pipe installed disclose leakage greater than that specified above, the Contractor shall at his own expense, locate and repair the pipe or joints that show evidence of leakage and repeat the test until the leakage is within the specified allowance.
2. Any cracked or defective pipe, fittings or valves shall be removed and replaced with sound material at the Contractor's expense and the test repeated to the satisfaction of the Owner.

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PRESSURE TEST REPORT FORM

PROJECT: _____ DATE: _____

CONTRACTOR: _____ JOB NO. _____

OWNER: _____ REPORT NO. _____

TEST LOCATION _____

GENERAL

System to Be Tested: _____

Location of Pipe: _____

Type of Pipe Material: DI/CI Steel Cu PVC HDPE Other _____

Length of Pipe Tested: _____ feet

SPECIFICATION

Type of Test: Hydrostatic Pneumatic Other _____

Bacteriological Test Required?: Yes No

Duration of Test: _____ hours

Test Pressure: _____ psi

Pressure / Gallons Loss Allowed: _____ psi/gallons

TEST DATA

Pressure Time

Start of Test: _____ psi _____ AM / PM

Completion of Test: _____ psi _____ AM / PM

Pressure / Gallons Lost at Finish: _____ psi/gallon

Results: Pass Fail

SYSTEM TEST PERFORMED BY:

Contractor Date

WITNESSED BY:

Engineer Date

ACCEPTED BY:

Owner Date

END OF SECTION

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SECTION 02929

SEEDING

PART 1 GENERAL

1.1 SUMMARY OF WORK

- A. Extent of seeded and sodded lawns is shown on drawings and by provisions of this section.
- B. Types of work required include the following:
 - 1. Soil preparation
 - 2. Top Soil
 - 3. Hydroseeding

1.2 RELATED WORK

- A. Related work specified elsewhere:
 - 1. Section 02200: Site Preparation and Earthwork
 - 2. Section 02930: General Landscape Materials and Final Grading

1.3 QUALITY ASSURANCE

- A. Seeding Subcontractor shall have a minimum 5 years experience with hydroseeding and related work.

1.4 SUBMITTALS

- A. Submit certification of grass seed from seed vendor for each grass seed mixture.
- B. Manufacturer's certification of fertilizer.
- C. Hydroseeder's certification of experience.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver seed in original sealed, labeled and undamaged containers.

1.6 PROJECT CONDITIONS

- A. Work notifications: Notify Engineer at least 7 working days prior to start of seeding operation.
- B. Protect existing utilities, paving and other facilities from damage caused by seeding operations.
- C. Perform seeding work only after planting and other work affecting ground surface has been completed.

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- D. Restrict traffic from lawn areas until grass is established. Erect signs and barriers as required.
- E. Provide hose and lawn watering equipment as required.

1.7 WARRANTY

- A. Hydroseeding shall be warranted for a period of 1 year following acceptance

PART 2 PRODUCTS

2.1 MATERIALS

- A. Grass Seed:
 1. Fresh, clean, dry, new-crop seed complying with the Association of Official Seed Analysts' - Rules for Testing Seeds - for purity and germination tolerances.
 2. Seed Mixture: Provide seed of grass species and varieties, proportions by weight, and minimum percentages of purity, and germination as indicated below.

Species	Min. Purity (%)	Germination (%)	Mixture Proportions (% by weight)
Kentucky Blue Grass	98	85	10
Perennial Rye Grass	96	85	20
Hard Fescue	97	85	30
Creeping Red Fescue	97	85	40

3. Rate: Apply seed mixture at a rate of 220 pounds per acre.
- B. Fertilizer:
 1. Granular, non-burning product composed of not less than 50% organic slow acting, guaranteed analysis professional fertilizer.
 2. Type A: Starter fertilizer containing 20% nitrogen, 12% phosphoric acid and 8% potash by weight or similar approved composition.
 - C. Ground limestone: Containing not less than 85% of total carbonates and ground to such fineness that 50% will pass through a 100 mesh sieve and 90% will pass through a 20 mesh sieve. Use if determined by soil tests to be necessary.
 - D. Water: Free of substance harmful to grass seed and grass growth. Hoses or other methods of transportation furnished by Contractor.
 - E. Topsoil
 1. Topsoil shall be fertile, friable and representative of productive soil, capable of sustaining vigorous plant growth and shall be free of clay lumps, sub-soil, weeds, seeds and other foreign debris.
 2. Acidity range shall be between pH 5.0 and 7.5.
 3. Organic content shall be not less than 5% and not greater than 30%.
 4. Clay content shall range between 5% and 25%.

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PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine finish surfaces, grades, topsoil quality and depth. Do not start seeding work until unsatisfactory conditions are corrected.

3.2 PREPARATION

- A. Limit preparation to areas which will be immediately seeded. Spread topsoil, fine grade.
- B. Treat lawn areas with "Round Up", by Monsanto, per label directions as required to kill existing vegetation prior to seeding.
- C. Scarify surface of lawn areas to minimum depth of 3". Remove stones over 1" in any dimension and sticks, roots, rubbish and extraneous matter.
- D. Apply 3" minimum topsoil to entire area to be seeded.
- E. Grade lawn areas to smooth, free draining and even surface with a loose, uniformly fine texture. Roll and rake; remove ridges and fill depressions as required to drain.
- F. Apply limestone, if required by soil test results, at rate determined by the soil test, to adjust pH of topsoil to not less than 6.0 nor more than 6.8. Distribute evenly by machine and incorporate thoroughly into topsoil.
- G. Apply Type A fertilizer at the rate equal to 1.0 lb. of actual nitrogen per 1,000 sq. ft. (43 lbs./acre). Apply fertilizer by mechanical rotary or drop type distributor, thoroughly and evenly incorporated with the soil to depth of 1" by discing or other approved methods. Fertilize areas inaccessible to power equipment with hand tools and incorporate it into soil.
- H. Dampen dry soil prior to seeding.
- I. Restore prepared area to specified condition if eroded, settled or otherwise disturbed after fine grading and prior to seeding.

3.3 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogenous slurry suitable for hydraulic application.
- B. Mix slurry with nonasphaltic tackifier.
- C. Apply slurry uniformly to all areas to be seeded in a 1-step process. Apply mulch at the minimum rate of 1500 lb per acre (16.5 kg per 100 sq. m) dry weight but not less than the rate required to obtain specified seed-sowing rate.
- D. Apply slurry uniformly to all areas to be seeded in a 2-step process. Apply first slurry application at the minimum rate of 500 lb per acre (5.5 kg per 100 sq. m) dry weight but not

less than the rate required to obtain specified seed-sowing rate. Apply slurry cover coat of fiber mulch at a rate of 1000 lb per acre (11 kg per 100 sq. m).

3.4 MAINTENANCE

- A. Proper maintenance shall be perform to adequately establish seed

3.5 CLEANING

- A. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, debris and equipment. Repair damage resulting from seeding operations.

END OF SECTION

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SECTION 02930

GENERAL LANDSCAPE MATERIALS AND FINAL GRADING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Handling and installation of existing top soil materials.
- B. Supply and installation of additional top soil materials.
- C. Final grading of topsoil for finish landscaping.

1.2 RELATED SECTIONS

- A. Section 01400 - Quality Control
- B. Section 02200 – Earthwork
- C. Section 02220 - Soil Erosion Control
- D. Section 02929 - Seeding

PART 2 PRODUCTS

2.1 TOPSOIL

- A. Topsoil, as provided by the Contractor, shall meet the following requirements:
- B. Topsoil shall be fertile, friable and representative of productive soil, capable of sustaining vigorous plant growth and shall be free of clay lumps, sub-soil, weeds, seeds and other foreign debris.
- C. Acidity range shall be between pH 5.0 and 7.5.
- D. Organic content shall be not less than 5% and not greater than 30%.
- E. Clay content shall range between 5% and 25%.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify building and trench backfilling have been inspected.
- B. Verify subsoil has been contoured and compacted.

3.2 SUBSTRATE PREPARATION

- A. Eliminate uneven areas and low spots.
- B. Remove debris, roots, branches, stones, in excess of 1/2 inch in size. Remove and replace subsoil contaminated with petroleum products.
- C. Scarify surface to a depth of 3 inches where topsoil is scheduled. Scarify in areas where equipment used for hauling and spreading topsoil has compacted subsoil.

3.3 PLACING TOPSOIL

- A. Place topsoil in areas as designated on the Contract Drawings, Thickness shall be as called for on the Contract Drawings. Place topsoil during dry weather.
- B. Fine grade topsoil to eliminate rough or low areas. Maintain profiles and contour of subgrade.
- C. Remove roots, weeds, rocks, and foreign material while spreading.
- D. Manually spread topsoil close to existing plant life, buildings and other above grade appurtenances to prevent damage.
- E. Compact placed topsoil as called for on the Contract Drawing.
- F. Remove surplus subsoil and topsoil from site.
- G. Leave stockpile area and site clean and raked, ready to receive landscaping, on both the facility site and remote storage site.

3.4 TOLERANCES

- A. Top of Topsoil: Plus or minus 1/2 inch.

3.5 PROTECTION

- A. Protect landscaping and other features remaining as final work.
- B. Protect all other structures, utilities, paving and other above grade appurtenances.

END OF SECTION

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SECTION 02990

PERMITS

PART 1 GENERAL

1.1 GENERAL

- A. The Permits included in this Section have been applied for by the Owner with the cost to the Contractor noted. They are provided as information for the Contractor because the requirements and regulations contained in these documents shall be adhered to by the Contractor as they pertain to the work done under this Contract.
- B. Should any contradictions or discrepancies between the requirements of the Permits Section and other Sections of these Specifications be found, this sections language shall have precedence.

1.2 RELATED SECTIONS

- A. Section 000_ITB – Instructions to Bidders
- B. Section 02110 - Site Clearing
- C. Section 02140 - Dewatering
- D. Section 02200 – Earthwork
- E. Section 02220 - Soil Erosion Control
- F. Section 02930 - General Landscaping Materials and Final Grading

1.3 PERMIT

- A. The following permits are contained hereinafter with costs to the Contractor noted.
 - 1. EGLE - Soil Erosion and Sediment Control Permit
 - 2. City of Ann Arbor - Building Permit
- B. The following permits are contained by the Engineer:
 - 1. EGLE Part 41 Permit

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 03300

CONCRETE WORK

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This section includes furnishing and mixing of materials required for concrete; furnishing, erecting, maintaining and removing formwork; designing concrete mixtures; transporting, placing, finishing, curing and protecting concrete; furnishing and placing reinforcement for concrete; and testing and evaluating concrete.

1.2 RELATED SECTIONS

- A. This provision is supplemental to all other sections within the specifications of the Contract related to the construction of concrete items for the project.
- B. Contractor shall refer to Specification Drawing titled "Concrete Specifications-1" for the following additional specification requirements:
1. Contractor shall refer to Specification.
 2. Concrete Slab Finishes
 3. Formwork Requirements
 4. Concrete Testing Agency Services
 5. Concrete Mixture Designs
 6. Required Concrete Mixtures
 7. Liquid Membrane Forming Compounds
 8. Molding Details
 9. Testing Concrete in Place
 10. Concrete Evaluation
 11. Approvals
 12. Concrete Test Set
 13. Patented Forms and Shores
 14. Weather Conditions
 15. Earth Forms
 16. Concrete Formed Surface Finishes
 17. Repair Surface Defects
 18. Contractor Responsibilities for Concrete Construction
 19. Preparation before Placing
 20. Ready Mix Concrete
 21. Concrete Curing
 22. Formwork and Shoring Removal
 23. Concrete Placement
 24. Mudmat
 25. Rubbed Surface Finish
 26. Removal of Laitance
 27. Concrete Protection
 28. Formed Surface Tolerance
 29. Concrete Placing Underwater

- 30. Manufacturer's Recommendations
 - 31. Grout Surface Finish
- C. The following items are shown on Drawing titled "Concrete Specifications-2":
- 1. Typical Slab and Wall Openings
 - 2. Reinforcement Embedment Lengths
 - 3. Reinforcement Lap Splice Lengths
 - 4. Reinforcement Notes
 - 5. Reinforcement Material
 - 6. Reinforcement Approvals
 - 7. Reinforcement Protection Concrete Cover
 - 8. Reinforcement Shop Drawings
 - 9. Reinforcement Embedment and Splice Notes Categories and Classes
 - 10. Reinforcement Abbreviations
 - 11. Reinforcement Symbols
 - 12. Typical Standee
 - 13. Reinforcement Bends and Standard 90° Hooks
 - 14. Hex Nut Splices
 - 15. Standard 90° Tie Hooks
 - 16. Reinforcement Placing
 - 17. Reinforcement Protection Epoxy Coating
 - 18. Reinforcement Fabricating
 - 19. Typical Equipment Pad Details
 - 20. Concrete Curb Details
 - 21. Embedded Electrical Conduits
 - 22. Reinforcement Tolerances
 - 23. Reinforcement Spacing
 - 24. Reinforcement Supports
 - 25. Mechanical Butt Splicers (Couplers)
 - 26. Threaded Rod Anchors
 - 27. Smooth W.W.F. Embedment
 - 28. Smooth W.W.F. Stylers
 - 29. Welding Reinforcement
 - 30. Smooth W.W.F. Lap Splices
- D. The following Items are shown on Drawing titled "Concrete Specifications-3":
- 1. Concrete Slab on Ground
 - 2. Anchoring Cement
 - 3. Neoprene Compression Seal
 - 4. Concrete Abbreviations
 - 5. Concrete Symbols
 - 6. Cold Joints
 - 7. Construction Joints
 - 8. Cement Mortar and Grout
 - 9. Epoxy Mortar and Grout
 - 10. Treatment of Hardened Concrete
 - 11. Metallic Waterproofing
 - 12. Joint Filler
 - 13. Waterstops – Type 1
 - 14. Waterstops – Type 2
 - 15. Watertight Concrete

16. Applied Surface Finish
17. Paper Joint
18. Concrete Placement Interval
19. Bonding Agent (Adhesive)
20. Repair of Cracks and Leaks
21. Nonshrink Grout
22. Shear Keys
23. Expansion Joint
24. Bond Breaker
25. Joint Sealant
26. Vapor Barrier
27. Control Joints – Walls
28. Embedded Items

1.3 REFERENCES

- A. American Concrete Institute (ACI):
 1. ACI 301 Specifications for Structural Concrete.
- B. American Society for Testing and Materials (ASTM):
 1. ASTM C 33 Standard Specification for Concrete Aggregates.
 2. ASTM C 150 Standard Specification for Portland Cement.
 3. ASTM C 618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 4. ASTM C 989 Standard Specification for Slag Cement for Use in Concrete and Mortars.
 5. ASTM C 1260 Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
 6. ASTM C 1293 Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
 7. ASTM C 1567 Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
- C. Michigan Department of Transportation (MDOT):
 1. MDOT Materials Source Guide.
 2. MDOT Standard Specifications for Construction, Latest Edition.

1.4 SUBMITTALS

- A. Concrete Mix Design(s)
 1. Each mixture submitted shall have a unique identification number.
 2. Each submittal shall include all the information listed in Table 1-1 of this Section for each mix in the submittal.
 3. Submit for review:
 - a. At least fourteen (14) calendar days prior to a Pre-Production Meeting if one is conducted.
 - b. At least fourteen (14) calendar days prior to the first placement of the concrete if a Pre-Production Meeting is not conducted.

1.5 QUALITY CONTROL

- A. Quality Control of all materials used on the project shall be the responsibility of the Contractor.
- B. Quality Assurance is not a substitute for Quality Control.
- C. The Contractor is responsible for adjustment of the Concrete Mix Design(s) during production, and to notify the Owner of such adjustments, to account for:
 - 1. Changing moisture conditions in the aggregate stockpiles.
 - 2. Changing weather conditions.
- D. The Contractor is responsible to submit new Concrete Mix Design(s) that may be required after construction commences in a timely manner to the Owner for review before such concrete is placed.
- E. For mixes with Optimized Gradations, the Contractor is responsible for providing the Owner daily updates on the aggregate blend during the entire course of production of the mixture.

1.6 QUALITY ASSURANCE

- A. The Owner will review the submitted Concrete Mix Design(s) for compliance to these specifications and provide the Contractor with a status of the review (Refer to Article 3.1).
- B. Concrete mixes shall be designed to be resistant to Deleterious ASR as defined in Article 2.1.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Concrete Mixtures:
 - 1. Shall be designed to be resistant to Deleterious ASR.
 - 2. Mixtures will be considered resistant to Deleterious ASR if one of the following can be demonstrated:
 - a. The alkalis in the cement expressed as equivalent sodium oxide (percent $\text{Na}_2\text{O} + 0.658 \times$ percent K_2O) are less than 0.60%.
 - b. The fine, intermediate (for HRC P1Mod Mixes) and coarse aggregates have been shown to have expansions of less than 0.10% when tested per ASTM C 1260 without any Supplementary Cementitious Material (SCM) replacement in the mortar bar.
 - c. The fine, intermediate (for HRC P1Mod Mixes) and coarse aggregates have been shown to have expansions of less than 0.10% when tested per ASTM C 1567 with the same SCM source and replacement % for cement as indicated on the Concrete Mix Design in the mortar bar.
 - 3. Mixtures may be considered resistant to Deleterious ASR if testing per ASTM C 1567 indicates an expansion of less than 0.10% for a mortar bar constructed using the same cement and SCM sources and the same aggregate sources and proportion of aggregates as indicated on the Concrete Mix Design.
 - 4. An ASTM C 1293 test alone will not be sufficient to show that an aggregate is non-reactive with respect to Deleterious ASR.

- B. Cement:
1. Cement may be replaced:
 - a. up to 35% by weight with Fly Ash, Class C or Class F.
 - b. up to 35% with GGBFS, Grade 100 or Grade 120.
 2. Cement type for "mass concrete" shall include:
 - a. An option of ASTM C595 type IP (MH), in lieu of C150, Type II, contingent upon meeting the same requirement of 28-day strength equal to 3500 psi with a maximum component weight of 19% fly ash (ASTM C-618 Class F).
 - b. An option of ASTM C150 Type 1, alone or in combination with up to 35% GGBFS, contingent upon the following: submittal of proposed methods to accomplish requirements; maximum concrete temperature at discharge of 70F; use of ice as mix water; continuous fog spray curing for min. 7 days as described in ACI Std. Practice 308-81; cement content, slump and strength requirements do not change from Type II requirements.
- C. Aggregates
1. Must be from geologically natural sources.
 - a. Aggregates produced from slag are not permitted.
- D. Fibrous Reinforcement
1. Fibrous concrete reinforcement shall be synthetic fibers specifically manufactured for use as concrete reinforcement, containing no reprocessed olefin materials. Fibrous concrete reinforcement shall be as manufactured by W.R. Grace & Co., 62 Whittmore Ave., Cambridge MA 02140, or approved equal.
 2. Physical Characteristics:
 - a. Specific gravity: 0.92
 - b. Tensile strength: 78 ksi
 - c. Fiber length: 1.5 inches
 3. Fibrous concrete reinforcement materials provided by this Section shall produce concrete conforming to the requirements for each type and class of concrete required as indicated on the Drawings and specified in this Section where the concrete is tested in accordance with the required testing methods ASTM C39, C78, and having a minimum modulus of rupture of 380 p.s.i.
 4. Add fibrous concrete reinforcement to concrete materials at the time concrete is batched in amounts in accord with approved submittals for each type of concrete required.
 5. Mix batched concrete in strict accord with fibrous concrete reinforcement manufacturer's instructions and recommendations for uniform and complete dispersion. Provide the services of a qualified technical representative to instruct the concrete supplier in proper batching and mixing of materials to be provided.
 6. Submit manufacturers printed product data, clearly marked, indicating proposed fibrous concrete reinforcement materials. Printed data should state 3.0 lbs. of fiber to be added to each cubic yard of each type of concrete.
 7. Submit copies of manufacturers printed batching and mixing instructions.
 8. Submit a certificate prepared by the concrete supplier stating that the approved fibrous concrete reinforcement materials at the rate of 3.0 lbs. per cubic yard were added to each batch of concrete delivered to the project site. Each certificate shall be accompanied by one (1) copy of each batch delivery ticket indicating amount of fibrous concrete reinforcement material added to each batch of concrete.

- E. Expanding Foam Joint Filler
1. Expanding foam joint filler shall be composed of an open cell polyester polyurethane foam doubly impregnated with neoprene rubber suspended in chlorinated hydrocarbons, supplied in precompressed, self-adhesive rolled tape form. Material shall be non-shrink, shall not dry out, and shall give a seal strength of 0.5 atmosphere or withstands a water pressure of 6 3/4 feet head of water at a compression of 20%.
 2. Other physical properties shall be as follows:

a. Density	8-10 lb./cu.ft.
b. Thermal Conductivity	0.05 K Cal/NRC
c. Temperature Stability Range	-40RF to 212RF
d. Bleeding	None
e. Tensile Strength	ASTM D2406 meets min. 21.8 psi
f. Resistance to Compression Set	ASTM D 1564 meets max. 2%
g. Peel Strength	ASTM D 1000 meets (at 1.57rad.) 0.25 revolution min.12N/25mm
h. Softening Point	ASTM D 816 Surpasses 50RC min.
i. Shear Strength	Min. 8N/cm ²
j. Mildew Resistance	Excellent
k. Staining	None
l. Flammability	Self-extinguishing per UL 94V-0
m. Flash Point	590RF (310RC)
 3. Expanding foam joint filler shall be installed in strict accordance with manufacturer's recommendations.

PART 3 EXECUTION

3.1 ACCEPTANCE OF STRUCTURE

- A. General
1. Completed concrete work which meets all applicable requirements will be accepted without qualification.
 2. Completed concrete work which fails to meet one or more requirements but which has been repaired to bring it into compliance will be accepted.
 3. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in these specifications. In this event, modifications may be required to assure that remaining work complies with the requirements.
- B. Mix Design
1. Mixtures that have been found to not be in compliance with this specification shall not be used for the work and shall be resubmitted to the Owner with revisions for further review.
- C. Dimensional Tolerances
1. Formed surfaces resulting in concrete outlines smaller than permitted by the tolerance shall be considered potentially deficient in strength.
 2. Formed surfaces resulting in concrete outlines larger than permitted by the tolerance may be rejected;² and the excess material shall be subject to removal. If removal of the excess material is approved, it shall be accomplished in such a manner as to

maintain the strength of the section and to meet all other applicable requirements of function and appearance.

3. Concrete members cast in the wrong location may be rejected if the strength, appearance, or function of the structure is adversely affected or misplaced items interfere with other construction.
4. Inaccurately formed concrete surfaces exceeding the tolerances and which are exposed to view, may be rejected and shall be repaired or removed and replaced if required.
5. Finished slabs exceeding the tolerances may be repaired provided that strength or appearance is not adversely affected. High spots may be removed with terrazzo grinder, or other remedial measures performed as approved.

D. Appearance

1. Concrete exposed to view with defects which adversely affect the appearance of the specified finish may be repaired only by approved methods.
2. Concrete not exposed to view is not subject to rejection for defective appearance.

E. Strength of Structure

1. The strength of the structure in place will be considered potentially deficient if it fails to comply with any requirements which control the strength of the structure, including but not necessarily limited to the following conditions:
 - a. Low concrete strength.
 - b. Reinforcing steel size, quantity, strength, position, or arrangement at variance with the requirements.
 - c. Concrete which differs from the required dimensions or location in such a manner as to reduce the strength.
 - d. Curing less than that specified.
 - e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
 - f. Mechanical injury, construction fires, accidents or premature removal of formwork likely to result in deficient strength.
 - g. Poor workmanship likely to result in deficient strength.
2. Structural analysis and/or additional testing may be required when the strength of the structure is considered potentially deficient.
3. Core tests may be required when the strength of the concrete in place is considered potentially deficient.
4. If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be required and their results evaluated in accordance with Chapter 20 of "Building Code Requirements for Reinforced Concrete" (ACI 318).
5. Concrete work judged inadequate by structural analysis or by results of a load test shall be reinforced with additional construction if so approved by the Engineer, or shall be replaced, at the contractor's expense.
6. The contractor shall pay all costs incurred in providing the additional testing and/or structural analysis required by this section.

Table 1-1. Requirements for Concrete Mix Design Submittals

General:

- NRMCA Certificate of Conformance for Concrete Production Facilities that spans the dates in which the project is be constructed.
- Scale Calibration/Test sheet from year(s) in which the project is constructed.
- Admixture / Dispenser Calibration Check Sheets from the year(s) in which the project is constructed.

Concrete Mix Design /Proportions Sheet:

- Project Name and Location
- Supplier Name
- Plant Location and Identification Number or Name
- Supplier Mix ID
- Supplier Mix Description and Use
- Batch Weights, Specific Gravities and Volumes occupied (yield) for all Materials, Dry or SSD
- Dosage Rates for Admixtures (oz./cwt)
- Dosage Rates for Materials such as Color Additives, Fibers etc.
- Volume Occupied by Air and Admixtures
- Design Yield
- Unit Weight for Mix
- Water to Cement Ratio for Mix
- Target Air Content and Tolerance Range
- Target Slump and Tolerance Range
- Anticipated 28-Day Strength

Performance Data

- Test data for strength, slump, air content and concrete temperature from within the two calendar years prior to the anticipated year of construction for the proposed mix.
- Statistical evaluation of the strength test data per ACI 301 (from 30 sets minimum):
 - Average 7 and 28 Day Strength
 - Standard Deviation of 28 Day Strength Tests
 - Required Average Strength based on Statistical Data
 - f'_{cr} for one Standard Deviation Unit
 - f'_{cr} for two Standard Deviation Units

Material Data:

- Cement
 - Supplier, Location and Type
 - Mill Test Report from the year(s) in which the project is constructed.
- SCM
 - Supplier, Location and Type or Class
 - Mill Test Report from the year(s) in which the project is constructed.
- Aggregates
 - Supplier, Source Name and MDOT ASI #, if applicable
 - Material Type and Aggregate Series/Class
 - Sieve Analysis for each Aggregate Series/Class from the calendar year in which the project is constructed.

- Test Results for Physical Properties from the calendar year in which the project is constructed.
- ASTM C 1260 or ASTM C 1567 mortar bar test results from either of the past two calendar year(s) prior to the year the project is constructed or the year(s) the project is constructed.
- Admixture Data Sheets
- Data Sheets and Test Results for Materials such as Color Additives, Fibers etc.

END OF SECTION

SECTION 03415

PRECAST CONCRETE HOLLOW CORE PLANKS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Roof planks.
- B. Connection plates and hangers.
- C. Grouting plank joint keys.

1.2 RELATED SECTIONS

- A. Section 03300 – Concrete Work.
- B. Section 05500 - Metal Fabrications: Supporting steel headers.
- C. Section 07900 - Joint Sealers: Caulking of butt joints of precast units at exposed underside of floor members.
- D. Section 09900: Painting.

1.3 REFERENCES

- A. ACI 301 - Structural Concrete for Buildings.
- B. ACI 318 - Building Code Requirements for Reinforced Concrete.
- C. ASTM A36 - Structural Steel.
- D. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- E. ASTM A416 - Uncoated Seven-Wire Low Relaxation Steel Strand for Prestressed Concrete.
- F. ASTM A615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- G. ASTM A666 - Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar for Structural Applications.
- H. ASTM C150 - Portland Cement.
- I. ASTM C1077 - Laboratories Testing Concrete and Criteria for Laboratory Evaluation.
- J. ASTM E 329 Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel and Bituminous Materials as Used in Construction.
- K. AWS D1.1 - Structural Welding Code.

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- L. AWS D1.4 - Structural Welding Code - Reinforcing Steel.
- M. PCI - Manual For The Design of Hollow Core Slabs.
- N. PCI MNL-116 - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.
- O. PCI MNL-124 - PCI Design for Fire Resistance of Precast Prestressed Concrete.
- P. PCI - Tolerances for Precast and Prestressed Concrete.
- Q. UL - Underwriters' Laboratories Inc., Fire Resistance Directory.
- R. MDOT - 1990 Standard Specifications for Construction.

1.4 DESIGN REQUIREMENTS

- A. Size components to withstand design loads as shown on the drawings.
- B. Maximum Allowable Deflection of Roof Planks: 1/240 span.
- C. Design components to accommodate construction tolerances, deflection of other building structural members and clearances of intended openings.
- D. Grouted Keys: Capable of transmitting horizontal shear force as shown on the drawings.
- E. Calculate structural properties of framing members in accordance with ACI 318.

1.5 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Shop Drawings: Indicate plank locations, unit identification marks, connection details, edge conditions, bearing requirements, support conditions, dimensions, openings, openings intended to be field cut, and relationship to adjacent materials.
- C. Product Data: Indicate standard component configuration, design loads, deflections, and cambers.
- D. Sealed calculations prepared by a Professional Civil Engineer, registered in the State of Michigan shall be submitted for Owner approval. Calculations shall include working load stresses under all loading conditions, ultimate strengths at maximum loading condition, deflections and cambers.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with the requirements of PCI MNL-116.
- B. Maintain plant records and quality control program during production of precast planks. Make records available upon request.
- C. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

- A. Fabricator: Company specializing in manufacturing the work of this section with three years documented experience.
- B. Erector: Company specializing in erecting the work of this Section with three years documented experience.
- C. Design precast concrete members under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State of Michigan.
- D. Welder: Qualified within previous 12 months in accordance with AWS D1.1.
- E. Testing Laboratory: Company meeting the criteria of ASTM C1077 and E329, specializing in testing with three years documented experience.

1.8 REGULATORY REQUIREMENTS

- A. Conform to ACI 318 code for design load and on-site construction requirements.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 01600.
- B. Lifting or Handling Devices: Capable of supporting member in positions anticipated during manufacture, storage, transportation, and erection.
- C. Mark each member with date of production and final position in structure.

1.10 COORDINATION

- A. Coordinate work under provisions of Section 01039.
- B. Coordinate the Work of framing components: anchor and weld plate locations, sleeve locations, and cautions regarding cutting or core drilling and directly associated with the Work of this section.
- C. Coordinate field cut openings with affected section.
- D. Coordinate location of hanger tabs and devices for mechanical and electrical work.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Concrete: Concrete shall attain a 28 day compression strength of 5000 psi minimum and shall have 6%± 1% air entrainment.
- B. Tensioning Steel Tendons: ASTM A416, Low relaxation type of sufficient strength commensurate with member design.

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- C. Reinforcing Steel: ASTM A615, deformed steel bars.
- D. Non-shrink Grout: Non-metallic, see Concrete specifications.
- E. Cement Grout: MDOT Section 7.02, Type R-3.

2.2 ACCESSORIES

- A. Connecting and Supporting Devices: ASTM A36 carbon steel; ASTM A666 stainless steel; plates, angles, and inserts.
- B. Core Hole End Plugs: Cardboard insert with stiff concrete fill.
- C. Hanger Tabs: Galvanized steel, designed to fit into grouted key joints, capable of supporting 200 lbs dead load, predrilled to receive hanger.
- D. Bearing Strips: High density plastic, 1/8 inch thick, smooth on one side.

2.3 FABRICATION

- A. Conform to AWS D1.4. and PCI MNL-116.
- B. Embed anchors, inserts, plates, angles, and other items at locations indicated.
- C. Provide openings required by other sections, at locations indicated.
- D. Cut exposed ends flush.

2.4 COMPONENTS

- A. Nominal Thickness: 8 inches.
- B. Nominal Plank Width: To suit opening sizes and locations.

2.5 FINISHES

- A. Plant Finish:
 - 1. Bottom: Finish Grade B (Suitable for Painting) - This finish should be as specified in Standard Grade (PCI MNL-116, C3.5.3) except that all surface blemishes should be filled or finished to provide a smooth surface of uniform appearance if painted. Form release or other agents should not leave any paint-rejecting coating on the concrete.
 - 2. Sides: Commercial Finish. Concrete may be produced in forms that impart a texture to the concrete (e.g., plywood or lumber). Fins and large protrusions shall be removed and large holes shall be filled. All faces shall have true, well-defined surfaces. Any exposed ragged edges shall be corrected by rubbing or grinding.
 - 3. Exposed vertical ends: Coat ends of strand and any depressions with bituminous material approved by the Owner. The ends of the members shall receive sacked finish.
 - 4. Top:

- a. Surface to receive topping slab: Screed and scratched. Final finish with stiff brush or rake to produce contact surface intentionally roughened to full aptitude of approximately 1/4 inch.
- b. Surface to remain exposed:
 - 1) Top: Result of vibrating screed and additional hand finishing at projections. Normal color variations, minor indentations, minor chips and spalls shall be permitted. No major imperfections, honeycomb, or defects shall be permitted.

B. Connecting and Supporting Steel Devices: Hot dip galvanized in accordance with ASTM A123.

2.6 FABRICATION TOLERANCES

A. Conform to PCI MNL-116.

2.7 SOURCE QUALITY CONTROL AND TESTS

- A. Provide testing of site placed concrete and grout under provisions of Section 01400.
- B. Provide shop inspection and mill certificates for stressing tendons.
- C. Test samples in accordance with specified ASTM and ACI standards.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify site conditions under provisions of Section 01039.
- B. Verify that site conditions are ready to receive work and field measurements are as indicated on shop drawings.
- C. Verify supporting structure is ready to receive work.

3.2 PREPARATION

- A. Prepare support devices for the erection procedure and temporary bracing.

3.3 ERECTION

- A. Erect members without damage to structural capacity, shape, or finish. Replace or repair damaged members.
- B. Align and maintain uniform horizontal and end joints, as erection progresses.
- C. Maintain temporary bracing in place until final connection is made. Protect members from staining.
- D. Install bearing strips and sill seal at bearing ends of planks.

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- E. Adjust differential camber between precast members to tolerance before final attachment and grouting.
- F. Adjust differential elevation between precast members to tolerance before final attachment.
- G. Install hanger tabs in joints at 48 inches
- H. Install core hole end plugs.
- I. Grout plank joints, trowel smooth.
- J. Place sealant backer rod to underside of plank joints to prevent grout leakage.
- K. Secure units in place.

3.4 ERECTION TOLERANCES

- A. Erect members level and plumb within allowable tolerances. Conform to PCI MNL-116.

3.5 PROTECTION OF FINISHED WORK

- A. Protect finished Work under provisions of Section 01500.
- B. Protect members from damage caused by field welding or erection operations.
- C. Provide non-combustible shields during welding operations.

3.6 CLEANING

- A. Clean weld marks, dirt, or blemishes from surface of exposed members.

END OF SECTION

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SECTION 03730

STRUCTURAL CONCRETE REPAIR

PART 1 GENERAL

- A. All structural concrete repairs as indicated on drawings shall apply to this section. The work includes:
 - 1. The controlled demolition of partial thickness/depth and the repair of delaminated and cracked concrete horizontal and vertical surfaces (and corners or edges);
 - 2. The controlled demolition of partial thickness for replacement of portions of slabs adjacent to embedded aluminum angle frames and/or walls of reinforced concrete.

1.1 SECTION INCLUDES

- A. Demolition, including:
 - 1. Providing measures for safety and construction protection.
 - 2. Demolishing designated construction.
 - 3. Protecting items designated to remain.
 - 4. Removing demolished materials.
- B. Preparation of concrete surfaces.
- C. Application and cure of repair materials.

1.2 RELATED SECTIONS

- A. Section 03300 – Concrete Work

1.3 REFERENCES

- A. ASTM C-109 Compressive Strength of Hydraulic Cement Mortars.
- B. ASTM C-157 Length Change of Hardened Cement Mortars and Concrete.
- C. ASTM C-882 Bond Strength.

1.4 SUBMITTALS

- A. Describe demolition schedule and removal procedures. Sequence activities to minimize disruption to Owner and Contractor operations.
- B. Shop Drawings:
 - 1. Indicate demolition and removal sequence.
 - 2. Indicate location of items designated for reuse and Owner's retention.
 - 3. Indicate location and construction of temporary work.
- C. The Contractor should submit prior to installation, for Owner's approval, manufacturer's literature and independent certified test data that material complies with requirements in Article 2.02.

1. Owner may choose, to buy any submitted material in the open marketplace, without the Contractor's or manufacturer's knowledge, and test material at an independent lab to verify compliance with this specification.
2. Compliance test failure may result in the testing and purchase costs being assigned as Contractor's expense.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. All repair materials shall be pre-mixed, pre-packaged materials requiring only the addition of water.
- B. They must be packaged in original, unopened package, clearly labeled with the manufacturer's identification and printed instructions.
- C. All material shall be stored and handled in accordance with recommendations of the manufacturer and the American Concrete Institute for Concrete and Concrete Products.

1.6 ENVIRONMENTAL CONDITIONS

- A. Refer to the manufacturer's literature for any physical or environmental limitations or contact the manufacturer directly.

PART 2 MATERIALS

2.1 REPLACEMENT MATERIALS

- A. The materials for replacement of reinforced concrete portions of wall and / or slab shall comply with specification section 03300

2.2 REPAIR PRODUCT MANUFACTURERS

- A. The following manufacturers supply materials which meet this specification and offer field service:
 1. Manufacturer
Five Star Products, Inc.
425 Stillson Road
Fairfield, CT 06430
Phone: 203-336-7900
Fax: 203-336-7930

2.3 REPAIR PRODUCTS

- A. Structural repair materials must be a one component system that requires just the addition of water. They must meet the following performance requirements at maximum water.
 1. Bond Strength: 1 Day 1500 psi
ASTM C-882* 7 Days 2500 psi
 2. Length Change: 28 Days Dry -0.05%
ASTM C-157I 28 Days Wet +0.05%
 3. Compressive Strength: 2 Hours 2500 psi

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ASTM C-109

1 Day
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2.4 AGGREGATE

- A. Aggregate shall only be used in strict compliance with product manufacturer's written recommendations; when used it shall consist of maximum 3/8" clean, washed, and dried gravel or crushed stone of reasonably uniform quality throughout.

PART 3 EXECUTION

3.1 SAFETY MEASURES

- A. Erect, and maintain temporary barriers and security devices including warning signs and lights, and similar measures, in compliance with MIOSHA standards, for protection of the Owner and existing improvements indicated to remain.

3.2 DEMOLITION

- A. Conduct demolition to minimize interference with adjacent and occupied building areas.
- B. Demolish in orderly and careful manner. Protect existing improvements, supporting structural members and all items indicated to remain in place..
- C. Carefully remove building components indicated to be reused.
 - 1. Disassemble components as required to permit removal.
 - 2. Package small and loose parts to avoid loss.
 - 3. Mark components and packaged parts to permit reinstallation.
 - 4. Store components, protected from construction operations, until reinstalled.
- D. Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.
- E. Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.
- F. Remove temporary Work.

3.3 PARTIAL THICKNESS REMOVAL

- A. Concrete removal methods for Partial Thickness Removal shall protect all sound concrete from damage by using only tools and equipment of types and sizes required to remove the intended unsound material.
- B. Where practical as determined by the Owner, the area to be repaired shall be saw cut on a specified line and depth to provide a shoulder for repair material and eliminate "feather-edged" repairs.

3.4 INSPECTION

- A. Inspect surfaces to receive structural repair material and verify the following:
 - 1. They are free of ice, frost, dirt, grease, oil, curing compounds, paints, impregnations, all loose material, and other foreign matters likely to affect the bond or performance of the material.
 - 2. Surfaces are sufficiently rough to ensure good cement bond and that the concrete is structurally sound.
 - 3. Provisions for expansion and control joints are consistent with specifications and sound engineering practices.

3.5 PREPARATION

- A. All grease, oil, dirt, curing compounds, laitance, and other deleterious materials must be completely removed from the concrete.
- B. Roughen the surfaces by chipping, sandblasting, or other mechanical means and provide a near vertical face on the edges of existing concrete to ensure bond. Loose or broken concrete shall be removed.
- C. If any existing rebar reinforcing is exposed, it will be sandblasted if excessive oxidation has taken place and coated with a high quality epoxy coating.
- D. All surfaces should be thoroughly saturated, and free standing excess water shall be removed with clean compressed air before applying the structural repair material.

3.6 INSTALLATION

- A. Carefully read and understand the manufacturer's instructions as printed on the container.
- B. Mixing - The mixing operation should be located close to the repair area. A mortar mixer is recommended. For smaller quantities, an electric drill and paddle mixer is recommended. The mixing order for mortar type mixer shall be as follows:
 - 1. Clean water shall be placed in the mixer at the rate specified on the container instructions. Water content is critical; do not deviate from the rate specified.
 - 2. When temperatures exceed 90°F, a pre-packaged set retarder shall be used as recommended by the manufacturer. Add retarder to mixing water maximizing dispersion in the mix.
 - 3. For large pours, 3/8-inch clean washed pea gravel should be added to the mix at a rate not to exceed 25 lbs. per 50 lb. pail.
 - 4. Add the repair material. This sequence is important in order to produce a consistent mix and to reduce mixing time. Allow approximately three minutes mixing time.
 - 5. When pouring large volumes of material, special consideration should be given to maintaining a continuous flow of material producing a wet leading edge. More than one mixer may be necessary to deliver enough material to insure no cold joints.
- C. Placing
 - 1. Horizontal - Place the mixed material into the prepared area starting from one side of the repair and working to the other side. Do not place the repair material in lifts. Work the material firmly into the bottom and sides of the repair. Screed the material

- to the desired level. Close up edges of the repair with a trowel. Finish the material to the desired texture.
2. Vertical - Using a trowel, move the material in an upward motion against the cut out substrate. Successive applications must be troweled against the previously placed material just prior to set. Build up the material to thickness desired. Finish the material to the desired texture.
 3. Do not re-temper the material. Clean the mixer and tools periodically with water to prevent build-up, especially in hot temperatures.
- D. Curing - As soon as the material sets, all exposed surfaces must be thoroughly saturated for 30 minutes.
- E. Clean Up - Upon completion of placement, equipment, and tools should be cleaned in such a manner as recommended by manufacturer.

PART 4 MEASUREMENT AND PAYMENT

4.1 UNIT PRICE – MEASUREMENT AND PAYMENT

- A. Measurement:
1. Partial Thickness Removal – Reinforced Concrete Slab: By the cubic foot.
 2. Repair Volume – Horizontal: By the cubic foot. Includes repair material volume in place.
 3. Partial Thickness Removal – Reinforced Concrete Slab Soffit: By the cubic foot.
 4. Repair Surface – Horizontal: By the square foot. Includes surface preparation, repair, and finishing.
- B. Basis of Payment:
1. Basis of Payment shall be determined by the unit price defined in the Bid Form and the actual Quantities installed.
 2. Removal items include all costs of labor, equipment and materials for safety measures, shoring, bracing, saw cutting, chipping, debris removal and disposal.
 3. Repair Surface items include costs of labor, equipment and materials for surface preparation, formwork, surface finishing and curing.
 4. Repair Volume items include costs of labor, equipment and materials for the purchase, storage, mixing and application of repair materials.

END OF SECTION

SECTION 04100

MORTAR AND MASONRY GROUT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Mortar and grout for masonry.
- B. Repointing of existing masonry where called for on the Drawings or specified.

1.2 RELATED SECTIONS

- A. Section 01400 – Quality Control.
- B. Section 04300 - Unit Masonry System: Installation of mortar and grout.
- C. Section 05500 – Metal Fabrications (Manholes and Covers Installation).
- D. Section 08115 - Custom Steel Frames: Mortaring of steel door frames.

1.3 REFERENCES

- A. TMS 402 - Building Code Requirements for Masonry Structures.
- B. TMS 602 - Specifications for Masonry Structures.
- C. ASTM C91 - Masonry Cement.
- D. ASTM C144 - Aggregate for Masonry Mortar.
- E. ASTM C150 - Portland Cement.
- F. ASTM C207 - Hydrated Lime for Masonry Purposes.
- G. ASTM C270 - Mortar for Unit Masonry.
- H. ASTM C387 - Packaged, Dry, Combined Materials, for Mortar and Concrete.
- I. ASTM C404 - Aggregates for Masonry Grout.
- J. ASTM C476 - Grout for Masonry.
- K. ASTM C780 - Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
- L. ASTM C1019 - Method of Sampling and Testing Grout.
- M. ASTM C1072 - Method for Measurement of Masonry Flexural Bond Strength.

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- N. ASTM E447 - Test Methods for Compressive Strength of Masonry Prisms.
- O. ASTM E518 - Test Method for Flexural Bond Strength of Masonry.
- P. IMIAC (International Masonry Industry All-Weather Council) - Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Include design mix, indicating the proportion specifications of the mix per ASTM C270.
- C. Samples: Submit two samples of mortar, illustrating mortar color and color range.
- D. Reports: Submit reports on mortar indicating conformance of mortar to property requirements of ASTM C270, component mortar materials to requirements of ASTM C270 and test and evaluation reports to ASTM C780.
- E. Reports: Submit reports on grout indicating conformance of component grout materials to requirements of ASTM C476 and test and evaluation reports to ASTM C1019.
- F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with TMS 402 and TMS 602.
- B. Maintain one copy of each document on site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Section 01600.
- B. Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Cold Weather Requirements: IMIAC - Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.
- B. Maintain materials and surrounding air temperature to maximum 90 degrees F (32 degrees C) prior to, during, and 48 hours after completion of masonry work.
- C. Environmental requirements shall meet the Michigan Building Code requirements, Section 2104 Construction, for both construction and protection.

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PART 2 PRODUCTS

2.1 MATERIALS

- A. Portland Cement: ASTM C150, Type I, gray-white.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Water: Clean and potable.
- D. For pigmented mortar, use a colored cement formulation as required to produce the color indicated or as selected from manufacturer's standard formulations.
 - 1. Pigments shall not exceed 10% of Portland cement by weight for mineral oxides nor 2% for carbon black.
 - 2. Pigments shall not exceed 5% of mortar cement or masonry cement by weight for mineral oxides nor 1% for carbon black.
- E. Bagged Masonry Cements.

2.2 ADMIXTURES

- A. No admixtures shall be used without the expressed written approval of the Engineer.
- B. It is not the intent of the Engineer to allow the use of admixtures.

2.3 MORTAR MIXES

- A. Mortar for Load Bearing Walls and Partitions: ASTM C270, Type S using the Proportion specification.
- B. Mortar for Non-Load Bearing Walls and Partitions: ASTM C270, Type S using the Proportion specification.

2.4 MORTAR MIXING

- A. Thoroughly mix mortar ingredients in accordance with ASTM C270 in quantities needed for immediate use.
- B. Maintain sand uniformly damp immediately before the mixing process.
- C. Do not use anti-freeze compounds to lower the freezing point of mortar.
- D. If water is lost by evaporation, re-temper only within two hours of mixing.
- E. Use mortar within two hours after mixing at temperatures of 90 degrees F (32 degrees C), or two-and-one-half hours at temperatures under 50 degrees F (10 degrees C).

2.5 GROUT MIXES

- A. Bond Beams, Lintels and other areas that may be called for on the Drawings: 2,000 psi (14 MPa) strength at 28 days; 8-10 inches (200-250 mm) slump; mixed in accordance with ASTM C476, fine grout.

2.6 GROUT MIXING

- A. Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C476 Fine grout.
- B. Do not use anti-freeze compounds to lower the freezing point of grout.

2.7 MIX TESTS

- A. Test mortar and grout in accordance with Section 01400.
- B. Testing of Mortar Mix: In accordance with ASTM C780 for compressive strength, consistency, mortar aggregate ratio, water content, air content, splitting tensile and strength.
- C. Testing of Grout Mix: In accordance with ASTM C1019 for compressive strength and slump.

2.8 REPOINTING SPECIFICATIONS

- A. Deteriorated mortar joints in existing Building masonry, and other areas that may be shown on the Drawings, shall be cleaned out and refilled with fresh mortar.
- B. All new mortar installed as part of this work shall match the color of the adjacent mortar for the area being worked on.
- C. Joints shall be considered deteriorated if they are eroded back 1/4 inch or more from the face of the masonry units; mortar has fallen out of the joint; hairline cracks run through the mortar; or the bond between mortar and masonry unit is broken.
 - 1. As a minimum, the Contractor shall include repointing of 3,000 lineal feet of mortar joints for the project.
 - 2. This repointing is in addition to specific areas specified or shown on the Drawings to be repaired. The Engineer shall mark in the field the areas that will be repointing.
 - 3. The repointing and repairs shall be done after new masonry weeps are installed.
- D. Raking the Old Mortar Joints:
 - 1. Mortar joints should be raked out to at least 1/2 inch depth or, if the joint is more than 1/2 inch thick, to a depth as great as the thickness of the mortar joint.
 - 2. If the mortar is still unsound at 1/2 inch, the joint shall be cut deeper.
 - 3. All unsound mortar shall be removed without disturbing the brick.
- E. Mortar may be removed with a hand-held grinder, a small mason's chisel, or a special raking tool.
 - 1. If the grinder is used to rake vertical joints, care shall be taken not to cut the brick in the next course above or below the joint.

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2. Before repointing, brush all loose fragments and dust from the joint or flush them out with a stream of water.
- F. Repointing mortar should closely match the existing mortar in strength, hardness, color, and texture.
- G. Test the existing mortar to see what mix proportions were used.
1. Type N mortar may be used if the original mortar can't be duplicated.
 - a. Type N mortar should be made from 1 part Portland cement, 1 part Type S hydrated lime, and 4 ½ to 6 parts sand.
 2. The mortar ingredients shall be high quality.
 - a. Portland cement (gray or white) shall meet the requirements of ASTM C 150, Type I or IA.
 - b. Hydrated mason's lime should meet the requirements of ASTM C 207, Type S. Hydraulic quicklime.
 - c. Sand should meet ASTM C 5 and C 144 requirements, respectively.
 - d. Do not use admixtures.
 3. To compensate for shrinkage, a prehydration process shall be used.
 - a. Mix the dry ingredients with only enough water to produce a damp, unworkable mix that retains its form when pressed into a ball.
 - b. Keep the mortar in this damp condition for 1 to 2 hours and then add the remaining water required.
 - c. Mortar for repointing should be somewhat drier than mortar used to lay masonry units.
 - d. This drier mix is easier to place:
 - e. It doesn't flow to the bottom of the joint after it's been pushed into the joint with the repointer's trowel.
 4. To see if the color of the new mortar matches the color of the old mortar, test a sample area in an inconspicuous spot before repointing the entire job.
 - a. Use a garden hose to soak a portion of the wall.
 - b. The color of the new mix should match the darker color of the wetted old mortar.
 - c. Minor adjustments, such as adding or subtracting sand or cement, may be necessary (but they must stay within the limits set by ASTM C 270 for the type of mortar selected).
 - d. A record shall be kept of the exact proportions so the same color can be reproduced in other batches throughout the job.
 5. Ordinary gray or white mortars can be retempered as needed within the first 2 ½ hours after they're mixed.
 6. Colored mortars shall not be retempered.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Request inspection of spaces to be grouted.

3.2 INSTALLATION

- A. Install mortar in accordance with ASTM C270.
- B. Mortar:
 - 1. "Measurement of materials for mortar shall be by volumetric measure and be controlled and accurately maintained. Measurement by "Shovel full" shall not be permitted."
 - 2. Mortar shall be retempered as required to maintain consistency. Dispose off site of mortar which has begun to stiffen, set or which is over 2-1/2 hours old.
 - 3. Follow color manufacturer's recommendations for re-temper colored mortar to avoid color mis-match."
- C. Work grout into masonry cores and cavities to eliminate voids.
- D. Do not install grout in lifts greater than 16 inches (400 mm) (two CMU courses without consolidating grout by rodding.
- E. Do not displace reinforcement while placing grout.
- F. Remove excess mortar from grout spaces.

3.3 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed in accordance with the Structural Tests and Special Inspections in TMS 602, refer to Table 4.
- B. Test and evaluate mortar in accordance with ASTM C780.
- C. Test and evaluate grout in accordance with ASTM C1019.

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SECTION 04300

UNIT MASONRY SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Face brick
- B. Concrete masonry units (CMU).
- C. Reinforcement, anchorage, and accessories.

1.2 RELATED SECTIONS

- A. Section 04100 - Mortar and Masonry Grout: Mortar and grout.
- B. Section 05500 - Metal Fabrications: Loose steel lintels, and fabricated steel items.
- C. Section 07620 - Sheet Metal Flashing and Trim: Cap flashings over masonry work.
- D. Section 07900 - Joint Sealants: Sealants and Backer Rod at control and expansion joints.

1.3 REFERENCES

- A. TMS 402 - Building Code Requirements for Masonry Structures.
- B. TMS 602 - Specifications For Masonry Structures.
- C. ASTM A82 - Cold-Drawn Steel Wire for Concrete Reinforcement.
- D. ASTM A123 - Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products.
- E. ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- F. ASTM A525 - Steel Sheet, Zinc Coated, (Galvanized) by the Hot-Dip Process.
- G. ASTM A580 - Stainless and Heat-Resisting Steel Wire.
- H. ASTM A615 - Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
- I. ASTM A641 - Zinc-Coated (Galvanized) Carbon Steel Wire.
- J. ASTM C62 - Building Brick (Solid Masonry Units Made from Clay or Shale).
- K. ASTM C90 - Load-Bearing Concrete Masonry Units.
- L. ASTM C216 - Facing Brick (Solid Masonry Units Made from Clay or Shale).

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- M. ASTM C652 - Hollow Brick (Hollow Masonry Units Made From Clay or Shale).
- N. IMIAC - International Masonry Industry All-Weather Council: Recommended Practices and Guide Specification for Cold Weather Masonry Construction.
- O. UL - Fire Resistance Directory.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide data for masonry units and fabricated wire reinforcement.
- C. Product Data: Provide data for masonry accessories, cleaning solution, dovetail anchors, flashing, joint filler, masonry mat, weep hole material, etc.
- D. Samples: Submit four samples of block units (if requested) to illustrate color, texture and extremes of color range.
- E. Manufacturer's Certificate: Certify that all masonry units covered by this specification meet or exceed all appropriate, referenced ASTM Specification requirements.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with TMS 402 and TMS 602.
- B. Maintain one copy of each document on site.
- C. Environmental requirements shall meet the Michigan Building Code requirements, Section 2104 Construction, for both construction and protection.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.7 PRE-INSTALLATION CONFERENCE

- A. Convene one week prior to commencing work of this section, under provisions of Section 01039.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 01600.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Cold Weather Requirements: IMIAC - Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.

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- B. Maintain materials and surrounding air temperature to maximum 90 degrees F (32 degrees C) prior to, during, and 48 hours after completion of masonry work.

1.10 COORDINATION

- A. Coordinate work under provisions of Section 01039.
- B. Coordinate the masonry work with Rough Stone veneer, installation of door frames and window anchors.

PART 2 PRODUCTS

2.1 FACE BRICK

- A. Face brick shall be ASTM C216, color, texture, module, size and finish shall match existing brick at Headworks Building exactly. Two different brick are being utilized on this project. Provide custom glaze color as required to match existing glazed brick units. Provide sample board for Owner review and approval.

2.2 CONCRETE MASONRY UNITS

- A. All masonry block units on the project shall be uniform in color. Units that are specified to receive pigment shall have the color uniform all the way through the unit.
- B. Hollow Load Bearing Block Units (CMU): medium weight, ASTM C-90.
- C. Solid Load-Bearing Block Units (CMU): medium weight, ASTM C-90.
- D. Standard Block Size and Shape: Nominal modular size of 8 x 16 x thickness shown having a smooth face. Provide special units for 90 degree corners, bond beams, lintels, and bullnosed corners.

2.3 REINFORCEMENT AND ANCHORAGE

- A. Single Wythe Joint Reinforcement: 2 wire, ladder type; steel wire, hot dip galvanized to ASTM A153 Class B2 after fabrication, 9 gage (3.7 mm) side rods with 9 gage (3.7 mm) cross ties.
 - 1. Approved Manufacturers:
 - a. Hohmann & Barnard, Inc.
 - b. Wire-Bond
 - c. Or other Engineer approved equal.
- B. Multiple Wythe Joint Reinforcement: 2 wire ladder type with 1/4" diameter adjustable veneer ties; steel wire, hot dip galvanized to ASTM A153 Class B2 after fabrication, 9 gage (3.7 mm) side rods with 9 gage inch (3.7 mm) cross ties. Length of adjustable wire ties to be coordinated with drawings.
 - 1. Approved Manufacturers:
 - a. Hohmann & Barnard, Inc., 270-ML
 - b. Wire-Bond, Series 800

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c. Or other Engineer approved equal.

- C. Prefabricated tees and corner pieces matching truss reinforcement.
- D. Anchors for securing CMU and brick to structural steel: Type 316 Stainless Steel 1 ¼” wide x 12 ga. bent edge strap anchors with separate adjustable 12 ga. Type 316 Stainless Steel channels welded to structural steel members. Hohmann & Barnard 365 Bent Gripstay Anchors with 360 Gripstay Channels, or approved equal.

2.4 MORTAR AND GROUT

- A. Mortar and Grout: As specified in Section 04100.

2.5 FLASHINGS

- A. Rubberized-Asphalt Flashing: Manufacturer’s standard composite flashing product consisting of a pliable and highly adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of 0.040 inch (1.0 mm).
 - 1. W.R. Grace & Co., Construction Products Division, Perm-A-Barrier Wall Flashing.
 - 2. Hohmann & Barnard, Inc., Textroflash.
 - 3. Williams Products, Inc., Everlastic MF-40.
- B. Asphalt Mastic: Asphalt based cement used as a bonding agent for bonding asphalt coated flashings to all construction surfaces.
 - 1. Hohmann and Barnard “Asphalt Mastic”.

2.6 ACCESSORIES

- A. Joint Filler (Backer Rod): Refer to Specification Section 07900 – Joint Sealers.
- B. Nailing Strips: Softwood, preservative treated for moisture resistance, dovetail shape, sized to masonry joints.
- C. Mortar Netting: Mortar net for use in vertical, multiple wythe cavity shall be “The Mortar Net” system, 10 inch high nylon mesh material with dovetail shape as manufactured by Mortar Net USA Ltd., suitable for wall cavity thickness shown on drawings.
- D. Mortar Mesh: Mortar mesh for use in horizontal joints to prevent mortar or grout from falling through; mesh shall be monofilament screen made from galvanized wire or polypropylene polymer, DUR-O-STOP as manufactured by Dur-O-Wall, Inc., or MGS – Mortar/Grout Screen by Hohmann & Barnard.
- E. Weep Hole Vents: Provide CavClear Weep Vents manufactured by CavClear/Archovations, Inc., Hudson WI 54016, (888)436-2620 or approved equal.
 - 1. Non-woven mesh with M notched bottom.
 - 2. Color to match mortar as selected by the Owner.
 - 3. Size: 3/8 inch by 2 ½ inches high by 3 ½ inches wide.
- F. Control Joint Filler: unless otherwise noted on the drawings, provide 3/8” thick, 3” wide, closed cell neoprene strip gasket. Use two 3” strips at CMU wall, for installed width of 6”.

- G. Cleaning Solution:
 - 1. Cleaning solution shall be as recommended by the cleaning solution manufacturer from their line of Masonry Cleaning Products.
 - 2. Approved manufacturers are Diedrich Technologies or ProSoCo.
 - 3. Manufacturer's printed recommendations and cleaning procedures shall be strictly followed.
 - 4. Submit Manufacturer's recommendations and procedures as part of the shop drawing submittals.

2.7 LINTELS

- A. Do not splice reinforcing bars.
- B. Support and secure reinforcing bars from displacement. Maintain position within 1/4 inch of dimensioned position.
- C. Place and consolidate grout fill without displacing reinforcing.
- D. Allow masonry lintels to attain specified strength before removing temporary supports.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Verify that foundations are within tolerances specified.
 - 2. Verify that reinforcing dowels are properly placed.
 - 3. Verify that the structural steel frame and miscellaneous metal work is complete, plumb, secured and properly located to allow masonry work to be installed as detailed and with adequate clearances.
- B. Foundation and steel frame discrepancies:
 - 1. Notify the Architect Engineer and Owner's Representative in writing of discrepancies.
 - 2. Foundation and/or steel frame discrepancies: Do not proceed with masonry work until conditions have been corrected.
 - 3. Foundation discrepancies affecting the masonry work shall be resolved by Foundation Contractor, the Masonry Contractor and the Owner Representative without Owner's extra cost.
 - 4. Steel Frame discrepancies affecting the masonry work shall be resolved by the Steel Frame contractor, the Masonry Contractor, and the Owner's Representative without Owner's extra cost.
- C. Before installation, examine rough-in and built-in construction to verify actual locations of piping connections.
- D. Verify that field conditions are acceptable and are ready to receive work. The Engineer shall be notified of any conditions not suitable to receive the Unit Masonry work.

- E. Verify items provided by other sections of work are properly sized and located.
- F. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.2 PREPARATION

- A. Direct and coordinate placement of metal anchors supplied to other sections.
- B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.3 COURSING

- A. Establish lines, levels, and coursing indicated. Protect from displacement.
- B. Lay out work carefully in advance to make joints, both horizontal and vertical, fit the openings with a minimum of cutting.
 - 1. Provide joints of uniform width. Form corners as true 90 degree angles unless otherwise shown.
 - 2. Exposed units shall be free from chips on faces and exposed edges, and from broken corners.
- C. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- D. Face Brick Units:
 - 1. Bond: Running.
 - 2. Lay up brick on a bed joint in a beveled peak away from the cavity to minimize mortar protrusions into the cavity.
 - 3. Do not furrow bed joints, butter ends of stretchers, and sides of headers if used, with mortar before laying. Fill vertical joints with mortar.
 - 4. Construct head joints by pushing units tightly into mortar against adjoining unit.
 - 5. Lay bricks with joints of uniform width, approximately 3/8 inch, with horizontal joints level and with vertical joints plumb.
 - 6. Tool exterior joints concave.
 - 7. Tool joints of interior brick walls concave.
 - 8. Provide special brickwork as required to complete the work.
 - a. Return brick into reveals at openings in walls.
 - b. Lay brick so that finished brick surface only is exposed in the finished work.
 - c. Where corner edges or cut brick are exposed, cut the brick with an abrasive saw, and provide cut brick with sharp, straight, true edges.
 - d. Refer to drawings for locations, elevations, and details of patterns of brick
- E. Concrete Masonry Units:
 - 1. Bond: Running.
 - 2. Coursing: One unit and one mortar joint to equal 8 inches (200 mm).
 - 3. Mortar Joints:
 - a. Lay up block units on a bed joint in a beveled peak away from the cavity to minimize mortar protrusions into the cavity.

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- b. Do not furrow bed joints, butter ends of stretchers, and sides of headers if used, with mortar before laying.
 - c. Fill vertical joints with mortar. Construct head joints by pushing units tightly into mortar against adjoining unit.
 - d. Lay units with joints of uniform width, approximately 3/8 inch, with horizontal joints level and with vertical joints plumb.
 - e. Tool exterior joints concave.
 - f. Tool joints of interior block walls concave.
- F. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.

3.4 PLACING AND BONDING

- A. Lay masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
- B. Masonry units with damaged or mutilated insulation inserts shall not be accepted.
- C. Cores to be grouted solid shall have the CMU cross webs set in a mortar bed to prevent the grout from flowing into the adjacent cells.
- D. Start the partitions on concrete floor slabs and extend to roof or floor construction above; except that where partitions are shown to terminate at suspended ceilings, extend partitions a minimum of 4 inches above such suspended ceilings, unless shown otherwise.
- E. Provide expansion joints in masonry work.
 - 1. Between top of masonry walls or partitions and underside of steel or concrete beams, metal deck, or concrete slabs; at ends of masonry walls or partitions abutting other construction, or other masonry walls or partitions except at tooth-bonded intersections; and elsewhere as shown; by packing the space with Expansion Filler.
 - 2. Provide the last course in such walls or partitions of solid units terminating to provide 3/8 inch space minimum.
- F. Install vertical mortar netting in nominal cavity between units if multiple wythes are used.
- G. Buttering corners of joints or excessive furrowing of mortar joints are not permitted.
- H. Remove excess mortar as work progresses.
- I. For the finished masonry walls that will not be painted:
 - 1. Avoid use of excess mortar.
 - 2. Remove excess mortar as work progresses.
 - 3. Immediately clean mortar from the face of the CMU or ACMU wall units.
 - 4. All precautions shall be taken to avoid staining of the finished surface of the masonry units.
- J. Interlock intersections and external corners. The intersection of all walls shall be toothed together with the intersecting wall.

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- K. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- L. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
- M. Broken or chipped masonry units will not be allowed. Care shall be taken during handling and installation to prevent any damage to the face and edges of all block units.
- N. Where built-in terms are to be embedded in cores of hollow masonry units, place a grout retainer in the in joint below and rod mortar or grout into core.
- O. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.
- P. Provide mortar beds on top of walls where walls support steel framing or precast concrete members. Build up mortar beds to provide elevations required to receive such members. Trowel surface of mortar beds true and level.
- Q. Fill the spaces between metal frames and masonry with grout.
- R. Use cores filled with mortar, or provide solid units for anchorage in locations where handrails, plumbing fixtures, utility cabinets and similar items are attached.
- S. Construct masonry walls and partitions of proper thickness to receive pipe, ducts, conduit and similar core-run items, whether or not so dimensioned. If room sizes or critical space requirements are affected by the need for larger units, obtain approval from the Owner's Representative before proceeding.
- T. Masonry work that shows evidence of having been frozen shall be removed and replaced with new materials.
- U. Masonry work shall never be placed on snow or ice covered surfaces. The surfaces shall be cleaned and dried prior to proceeding with the new masonry work.
- V. Wet or frozen masonry units shall not be used until they are allowed to dry.
- W. All Masonry walls shall be covered at night or whenever work is not underway to prevent moisture entry into the wall.
 - 1. Finished walls shall have the tops of exposed walls covered to prevent moisture entry into the wall.
 - 2. Wall covering shall be waterproof tarps, reinforced polyethylene sheets or other approved waterproof barrier, anchored in place so they will not be displaced by the weather.

3.5 WEEPS

- A. Place weep vents in head joints of exterior wythes of cavity wall located immediately above ledge and flashing, spaced 24" on center, unless otherwise shown.

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- B. Leave the side of the masonry units forming the weep vent space unbuttered and clear of mortar. Install with the notched side down.
- C. Slide vent material into place once the two masonry units forming the weep are in place.

3.6 REINFORCEMENT AND ANCHORAGE – SINGLE AND MULTIPLE WYTHE MASONRY

- A. Install horizontal joint reinforcement 16 inches (400 mm) oc.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below all sills, lintels and other openings. Extend each side of opening from control joint to control joint.
- C. Place joint reinforcement continuous in first and second joint below top of walls.
- D. Lap joint reinforcement ends minimum 6 inches (150 mm).
- E. Install pre-fabricated corners and tees.
- F. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch (13 mm) of dimensioned position.
- G. Provide reinforced walls or piers in locations shown. Install vertical reinforcing in block cores, of sizes and at spacings shown.
 - 1. Loop and wire-tie to dowels at bottom.
 - 2. If splicing of reinforcing is required, lap joints and wire-tie as required by the codes.
 - 3. After mortar has set, fill cores containing reinforcing with grout.
 - 4. If only segments of a wall are reinforced, provide setting mortar on cross-webs adjacent to segment, during laying, to contain the grout in the reinforced cores.

3.7 MASONRY FLASHINGS

- A. Extend flashings horizontally at foundation walls, above ledge or shelf angles and lintels, under parapet caps, and at bottom of walls.
- B. Turn flashing up minimum 8 inches (200 mm) and bed into mortar joint of masonry, seal to concrete, seal to steel or other back-up.
- C. For single wythe masonry unit walls provide a double wythe to allow embedment of the flashing between the two wythes.
 - 1. The double wythe only needs to be 1 course high.
 - 2. General installation shall follow requirements for multi-wythe walls as shown on the Drawings.
- D. Lap end joints minimum 6 inches (150 mm) and seal watertight.
- E. Turn flashing, fold, and seal at corners, bends, and interruptions.

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3.8 LINTELS AND BOND BEAMS

- A. Install loose steel where shown on the Drawings.
- B. Provide concrete masonry lintel units matching the stretcher units in size and texture for lintels at locations with openings greater than 24 inches.
 - 1. Place reinforcing bars as shown and fill void with grout.
 - 2. Construct lintel with a minimum of 8 inches of bearing at each end.
 - 3. Where lintel is exposed in final construction, match the bond pattern used in the wall.
 - 4. Cure field fabricated lintels before handling and installing or temporarily support built-in-place lintels until cured.
- C. Provide concrete masonry bond beam units or other methods of grout confinement for bond beams.
 - 1. Place reinforcing bars as shown and fill void with grout.
 - 2. For continuous bond beams, lap reinforcing bars 12 inches minimum and provide bars around corners.
 - 3. Tie bond beams to structural members as shown.
- D. Install reinforced unit masonry lintels over openings, where steel or precast concrete lintels are not scheduled.

3.9 GROUTED COMPONENTS

- A. Place horizontal mortar mesh over cores below grouted course(s).
- B. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch (13 mm) of dimensioned position.
- C. Place and consolidate grout fill without displacing reinforcing.
- D. At vertical reinforcing steel locations, grout cores solid as shown on the Drawings.
 - 1. Insulation inserts shall remain in the grouted cores.
 - 2. Insulation inserts shall be tight to the interior surface of the block prior to the grout placement.

3.10 CONTROL AND EXPANSION JOINTS

- A. Do not continue horizontal joint reinforcement through control and expansion joints.
- B. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.
- C. Size control joints as shown on the Drawings and in accordance with Section 07900 for sealant performance.
- D. Construct typical control joints and expansion joints by breaking the running bond in the wall with a continuous thru-wall vertical joint 3/8 inch wide and provide 1/2 inch deep sealant space.

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1. In concrete masonry unit work, construct the control joint by laying up the block with the half core end at the joint; as concrete masonry units are laid up, line one side of the joint with 1 ply of Bond Breaker Strip and fill the core and web space formed at the joint with mortar, packed in place, to form a keyed joint which will withstand lateral pressure.
2. In brick-concrete masonry unit work, or brickwork, fill the joint with Flexible Joint Filler Strip, recessing the strip to provide the 1/2 inch deep sealant space.

E. Isolation Joints

1. Provide isolation joints wherever masonry encloses a steel column and elsewhere as shown.
2. Construct joints by separating the masonry from the steel with Isolation Gaskets. Do not compress the Isolation Gasket.

3.11 BUILT-IN WORK

- A. As work progresses, install built-in metal door frames, fabricated metal frames, window frames, wood nailing strips, anchor bolts, plates, and other items to be built-in the work and furnished by other sections.
- B. Install built-in items plumb level and true to line.
- C. Bed anchors of metal door frames in adjacent mortar joints. Fill frame voids solid with mortar. Fill adjacent masonry cores with mortar minimum 12 inches (300 mm) from framed openings.
- D. Do not build in organic materials subject to deterioration.

3.12 TOLERANCES

- A. Maximum Variation from Alignment of Columns or Pilasters: 1/4 inch.
- B. Maximum Variation from Unit to Adjacent Unit: 1/32 inch.
- C. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.
- D. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
- E. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.
- F. Maximum Variation of Joint Thickness: 1/8 inch in 3 ft.
- G. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.
- H. Maximum Variation of Head Joint Alignment, Every Second Course: 1/8 inch in 2 ft and 1/4 inch in 8 ft.

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3.13 CUTTING AND FITTING

- A. Cut and fit for chases, pipes, conduit, sleeves, grounds, etc. Coordinate with other sections of work to provide correct size, shape, and location.
- B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.14 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 01400.
- B. Field Inspections / Quality Assurance.
 - 1. Special masonry inspections shall be required for engineered masonry that is part of non essential buildings as defined MBC Section 1705.4.
 - a. Refer to Structural drawings for additional requirements and criteria.
 - b. Seismic resistance testing shall be in accordance with MBC Section 1705.13.

3.15 CLEANING

- A. Clean work under provisions of 01700.
- B. Clean exposed surfaces of masonry thoroughly to remove mortar, dirt, paint spots, stains, efflorescence and defacements.
 - 1. Protect exposed adjacent materials during installation and cleaning operations.
 - 2. Remove mortar droppings from aluminum and other metal surfaces daily.
 - 3. Do not use sand blast, or other materials or methods that will stain, discolor, or damage the masonry surfaces in any way.
- C. Point up joints full and even and to match tooling used on wall.
 - 1. Cut out and point up defective joints during or before cleaning.
 - 2. Clean out and provide proper-depth recesses for caulking and sealing work.
 - 3. Mortar shall match adjacent installations in color and texture.
- D. Brush clean concrete masonry units as the work progresses.
 - 1. Allow mortar droppings on such surfaces to dry and then remove by trowel, block-rubbing and brushing.
- E. Protect surfaces that could be harmed by cleaning operations.
- F. Clean face brick with warm water, detergent and fiber brushes.
 - 1. IF such cleaning is ineffective, use specified brick cleaning solution following the manufacturer's instructions.
 - 2. Cleaning solutions from Diedrich or ProSoCo may be used as necessary to remove stains from the masonry block and must be approved by the Engineer prior to starting the work.
 - a. The Contractor shall start with the mildest cleaning solution available and work to the stronger cleaning agents if the stains persist.
 - b. All solutions shall be tested in inconspicuous places to verify that they are not detrimental (change texture or color) to the appearance of the wall surface.

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3. Immediately flush surfaces thoroughly with clean, clear water.
 4. Also, immediately flush adjacent surfaces upon which solution has dropped or splashed. Do not use high-pressure power washers.
 5. The walls shall be cleaned as many times as necessary to remove stubborn and persistent stains.
 6. If stains are such that they cannot be successfully removed from the surface of the masonry unit, the masonry unit shall be cut from the wall and a new non-stained masonry unit matching the existing wall units shall be tuck-pointed into place.
- G. It is the Owner and the Engineer's intention to have a uniform appearance in the final wall surfaces.
- H. For soiled stone surfaces, clean joints and exposed surfaces with fiber brush and soap powder and rinse thoroughly with water.
- I. Clean glazed face material units with detergent, warm water and fiber brushes.
- J. Remove all excess materials, debris, equipment, sample panels, etc. From site upon completion and acceptance of masonry work.
- K. Use non-metallic tools in cleaning operations.

3.16 PROTECTION OF FINISHED WORK

- A. Protect finished Work under provisions of Section 01500.
- B. All new masonry walls shall be protected at night to prevent the entrance of moisture into the exposed top of walls.
1. Wall protection shall be provided until such time as the wall is permanently protected from moisture by subsequent construction.
 2. Walls not being actively worked on shall be protected from moisture continuously during the work interruption.
 3. Wall coverings shall be plastic or canvas as approved by the Engineer.
 4. Wall coverings shall be held in place securely to prevent being displaced by wind or weather conditions.
- C. Without damaging completed work, provide protective boards at exposed external corners which may be damaged by construction activities.
- D. If masonry work becomes stained after the cleaning process has been completed and prior to acceptance of the completed building by the Owner, the Contractor shall clean the walls again, in accordance with the above specified procedures, to make them acceptable.

END OF SECTION

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SECTION 04451

CUT LIMESTONE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Cut limestone sills at window openings.
- B. Metal anchors, mortar, and joint pointing.

1.2 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Section 05500 - Metal Fabrications: Metal fabricated items for building into cut stone.
- B. Section 07620 - Sheet Metal Flashings and Trim: Sheet metal flashings.

1.3 RELATED SECTIONS

- A. Section 04100-Mortar and Masonry Grout: Limestone bed and joints.
- B. Section 04300-Unit Masonry System: Masonry supporting wall.
- C. Section 05500 - Metal Fabrications: Shelf angles and supports.
- D. Section 07620 - Sheet Metal Flashing and Trim: Coping, lintel, and sill flashings.
- E. Section 07900 - Joint Sealants: Sealant and backer rod for limestone installation.

1.4 REFERENCES

- A. ASTM A123 - Zinc (Hot Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
- B. ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- C. ASTM C270 - Mortar for Unit Masonry.
- D. ASTM C387 - Packages, Dry, Combined Materials for Mortar and Concrete.
- E. ASTM C568 - Limestone Building Stone.
- F. ILI (Indiana Limestone Institute of America, Inc).
- G. IMIAC (International Masonry Industry All-Weather Council) - Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.

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1.5 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Shop Drawings: Indicate layout, pertinent dimensions, anchorages, reinforcement, head, jamb, and sill opening details, control jointing methods.

1.6 QUALITY ASSURANCE

- A. Perform work in accordance with ILI Standard Specifications.

1.7 QUALIFICATIONS

- A. Stone Supplier: Company specializing in quarrying cut stone with minimum ten years experience.
- B. Installer: Company specializing in performing the work of this section with minimum three years experience.
- C. Design anchors and supports under direct supervision of a registered Professional Structural Engineer, registered in the State of Michigan.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Section 01600.
- B. Store stone panels on a pallet, off the ground.
- C. Protect stone from discoloration.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Cold Weather Requirements: IMIAC - Recommended Practices and Specifications for Cold Weather Masonry Construction.
- B. During temporary storage on site, at the end of working day, or during rainy weather, cover stone work exposed to weather with non-staining waterproof coverings, securely anchored.

1.10 SEQUENCING

- A. Sequence work under the provisions of Section 01010.
- B. Sequence work to coordinate the installation of stone work with installation of adjacent construction.

PART 2 PRODUCTS

2.1 LIMESTONE

- A. Limestone: Cut Indiana Oolitic Limestone.

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- B. Grade: Select.
- C. Color: Match existing sills at Headworks building, pending owner approval.
- D. Surface Texture: Smooth.

2.2 ACCESSORIES

- A. Anchors, Dowels, and Ties: Stainless steel to ASTM A167, Type 316, of sizes and configurations required for support of stone and applicable superimposed loads.
- B. Supports: Stainless steel Type 316.
- C. Bolts, Washers and Nuts: Stainless steel Type 316.
- D. Setting Shims: Plastic type.
- E. Spacers: Plastic Type.
- F. Flashings: Specified in Section 07620.
- G. Sealant: Specified in Section 07900, to match stone color.
- H. Cleaning Solution: Type which will not harm stone, joint materials, or adjacent surfaces.

2.3 MORTAR MIX

- A. Setting Mortar: Type M using the Property Method.
- B. Do not use anti-freeze compounds to lower the freezing point of mortar.
- C. If water is lost by evaporation, re-temper only within two hours of mixing.
- D. Use mortar within two hours after mixing at temperatures of 80 degrees F (26 degrees C), or two-and-one-half hours at temperatures under 50 degrees F (10 degrees C).

2.4 STONE FABRICATION

- A. Thickness and Face Size: As shown and detailed on the Drawings, cut square.
- B. Fabrication Tolerances: Shall be in accordance with ILI Standards
- C. Fabricate units for uniform coloration with adjacent units and over the full area of the installation.
- D. Slope exposed top surfaces of stone and horizontal sill surfaces for natural wash.
- E. Cut drip slot in work projecting more than 1/2 inch (13 mm) over adjacent work. Size slot not less than 3/8 inch (10 mm) wide and 1/4 inch (6 mm) deep; full width of projection.

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PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that support work and site conditions are ready to receive work or this section.
- B. Establish lines, levels, and coursing. Protect from disturbance.

3.2 PREPARATION

- A. Establish lines, levels, and coursing. Protect from disturbance.
- B. Verify that items built-in under other sections are properly located and sized.
- C. Clean stone prior to erection. Do not use wire brushes or implements which will mark or damage exposed surfaces.

3.3 INSTALLATION

- A. Install flashings of longest practical length and seal water tight to back-up. Lap end joint minimum 6 inches (150 mm) and seal watertight.
- B. Erect stone in accordance with stone supplier's instructions and erection drawings.
- C. Arrange stone pattern to provide a consistent joint width of 3/8 inch.
- D. Provide setting bed, backer rod and sealant in accordance with Sections 04100 and 07900.
- E. Place setting buttons and set stone in full mortar setting bed to support stone over full bearing surface and to establish joint dimensions.
- F. Shore up units until setting bed will maintain stone in position without movement.
- G. Fill dowel and lifting holes with mortar.
- H. To accommodate backer rod and sealant, rake out joints 3/4 to 1 inch. Brush mortar joints clean.

3.4 TOLERANCES

- A. Positioning of Elements: Maximum 1/4 inch (6 mm) from true position.
- B. Maximum Variation from Plane of Wall: 1/4 inch in 10 feet (6 mm in 3 m); 1/2 inch in 50 feet (13 mm in 15 m).
- C. Maximum Variation Between Face Plane of Adjacent Stones: 1/16 inch (1.5 mm).
- D. Maximum Variation of Joint Thickness: 1/8 inch in 3 feet (3 mm/m).

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3.5 CUTTING AND FITTING

- A. Obtain approval prior to cutting or fitting any item not so indicated on Drawings.
- B. Do not impair appearance or strength of stone work by cutting.

3.6 CLEANING

- A. Remove excess mortar upon completion of work.
- B. Clean soiled surfaces with cleaning solution.
- C. Use non-metallic tools in cleaning operations.

END OF SECTION

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SECTION 05051

ANCHORS

PART 1 GENERAL

1.1 SUMMARY

- A. This section includes anchorage for equipment, appurtenance, and supports to concrete, brick, and block substrates, and is to be used in conjunction with the design drawings or Specifications, including:
 - 1. Cast-in-place anchors.
 - 2. Post-installed anchors.
- B. The requirements specified herein shall supplement anchorage criteria specified on the design drawings and related sections. Discrepancies between this section, related sections, or the design drawings shall be governed by the following order of importance:
 - 1. Design drawings.
 - 2. Related sections.
 - 3. This section.
- C. This section is intended to address the use and design of anchors for applications such as process mechanical and electrical equipment support, piping and ductwork support and bracing, cladding and façade connections, or rebar doweling.

1.2 RELATED SECTIONS

- A. Section 01300 - Submittals
- B. Section 01600 Materials
- C. Division 3 Concrete Sections.
- D. Division 4 Masonry Sections.
- E. Division 5 Metals Sections.
- F. Division 11 Equipment
- G. Division 15 Mechanical
- H. Division 16 Electrical
- I. Design Drawings.

1.3 REFERENCES

- A. American Concrete Institute (ACI):
 - 1. ACI 318 – Building Code Requirements for Structural Concrete and Commentary.
 - 2. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures.

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3. ACI 355.2 – Qualification of Post-Installed Mechanical Anchors in Concrete.
4. ACI 355.4 – Qualifications of Post-Installed Adhesive Anchors in Concrete.

B. American Society of Tests and Materials (ASTM): Latest versions of:

1. ASTM A108 – Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
2. ASTM A153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
3. ASTM A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
4. ASTM A449 – Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use.
5. ASTM A510 – Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel.
6. ASTM A563 – Standard Specification for Carbon and Alloy Steel Nuts.
7. ASTM A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
8. ASTM B633 – Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
9. ASTM E488 – Standard Test Methods for Strength of Anchors in Concrete Elements.
10. ASTM F593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screw, and Studs.
11. ASTM F594 – Standard Specification for Stainless Steel Nuts.
12. ASTM F436 – Standard Specification for Hardened Steel Washers Inches and Metric Dimensions.
13. ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

C. 2015 Michigan Building Code (MBC):

D. Manufactures Standard Society (MSS):

1. MSS PS 58 – Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

E. The Masons Society (TMS): Latest Edition:

1. TMS 402 – Building Code Requirements for Masonry Structures.
2. TMS 602 – Specifications for Masonry Structures.

1.4 DEFINITIONS

- A. Anchors: Anchors include the anchor, nuts, washers, and all other hardware.
- B. Cast-in-Place Anchors: Anchors installed in formwork and prior to placing concrete.
- C. Post-Installed Anchors: Anchors installed into hardened concrete such as adhesive anchors and mechanical anchor types, including wedge and screw anchors.

1.5 DESIGN REQUIREMENTS

- A. Design Delegation: Unless anchorage type, size, and embedment depth are explicitly specified on the Design Drawings or in the Specifications; anchorage design shall be delegated to the Contractor. The Contractor may further delegate anchorage design to their sub-contractors, equipment manufacturers, or suppliers as applicable.
- B. Governing Design Code: Design for anchorage shall be performed in accordance with the current edition of the MBC.
- C. General:
1. Design shall consider creep, in-service temperature, and installation temperature.
 2. Anchor capacity used in design shall be based on the technical data published by the manufacturer. Anchorage design may utilize the Manufacturer's proprietary design software, or other such methods approved by the Engineer.
- D. Design Loads:
1. Equipment: In accordance with the Contract Documents and equipment manufacturer's standard design practice.
 2. Pipe and conduit: In accordance with pipe and conduit loads, spacing, span, location, and other factors, in conjunction with SSP MS-58.
 3. Design loads include all applicable loads, such as dead load, live load, startup load, wind loads, seismic loads, dynamic loads, and fluid loads.
 4. If design loads cannot be determined, anchorage shall be designed for the maximum shear and tension that can be transmitted to the anchor or group of anchors based on the development of a ductile yield mechanism in anchor.
- E. Anchorage to Concrete:
1. Design shall comply with the current edition of ACI 318 Chapter 17 or ACI 350 Appendix D, as applicable. Refer to the structural design drawings for the applicable ACI code.
 2. Anchorage into concrete shall consider the concrete to be in a *cracked concrete* state, regardless of the concrete's condition at time of installation.
 3. Specified compressive strength of concrete ($f'c$) shall be assumed to be 2,500 psi, unless documentation verifying concrete's compressive strength is provided to the Engineer for review.
- F. Anchorage to Hollow Core Concrete Panel:
1. Design shall comply with the current edition of ACI 318 Chapter 17.
 2. Anchorage into concrete shall consider the concrete to be in a *cracked concrete* state, regardless of the concrete's condition at time of installation.
 3. Specified compressive strength of concrete ($f'c$) shall be assumed to be 3,000 psi, unless documentation verifying concrete's strength is provided to the Engineer for review.
- G. Anchorage to Brick or Block:
1. Design shall comply with the current edition of TMS 402 Chapter 6.
 2. Specified compressive strength of masonry ($f'm$) shall be assumed to be 1,500 psi, unless documentation verifying masonry unit strength is provided to the Engineer for review.

1.6 SUBMITTALS

- A. Submit under provisions of Section 01300.
 - 1. Anchorage submittal shall be included with all equipment, mechanical, electrical and support submittals.
 - 2. Equipment and support submittals supplied without the associated anchorage submittal will be rejected.

- B. Submittals for Review:
 - 1. Calculation Package:
 - a. Anchorage design calculation report shall be submitted with the respective equipment and hangers/support submittal.
 - b. Indicate design loads parameters and dimensions.
 - c. Submittal shall include the application design report, proprietary to each manufacturer.
 - 2. Product specifications and data with recommended design values and physical characteristics for adhesive and mechanical anchors, including:
 - a. Product Information.
 - b. Technical Information.
 - c. Material Safety Data Sheets (MSDS).
 - 3. Manufacturer's published installation instructions (MPII).

- C. Quality Assurance Submittals:
 - 1. Certificates for post-installed anchors: ICC-ES or IAPMO-UES Evaluation Reports compliance with specified performance characteristics and physical properties as specified in the MBC, and ACI 355.2 or ACI 355.4 as applicable.
 - 2. Installer Qualifications & Procedures: Submit installer qualifications as stated in Section 1.7. Submit procedures stating method of drilling, the product proposed for use, the complete installation procedure, manufacturer training date, and a list of the personnel to be trained on anchor installation.
 - 3. Special Inspector Qualifications.

- D. Special Inspections Testing Reports:
 - 1. Contractor to engage the services of an independent qualified third-party special inspection testing agency to provide testing and documentation of said testing to show compliance with MBC Chapter 17, specifically in relation to the following components:
 - a. Installation conformance reports.
 - b. Proof-load test reports.

1.7 QUALIFICATIONS

- A. Designers Qualifications: Anchorage shall be designed by a Professional Engineer, currently licensed, and experienced in design of this work. (load qualification)

- B. Installer Qualifications: Anchors shall be installed by an installer who has completed Installer Training as stated in Section 1.8 and with at least three years of experience performing similar installations.

- C. Special Inspectors Qualifications: Third-party special inspector with at least three years of experience inspecting similar installations. Acceptable third-party special inspection firms include:
 - 1. G2 Consulting Group.
 - 2. NTH Consultants, Ltd.
 - 3. Soil and Materials Engineer, Inc.
 - 4. Somat Engineering, Inc.
 - 5. Testing Engineers & Consultants, Inc.

1.8 QUALITY ASSURANCE

- A. Installer Training: Conduct a thorough training with the manufacturer or the manufacturer's representative for the installer on the project. Training to consist of a review of the complete installation process for adhesive anchors, to include but not limited to:
 - 1. Hole drilling procedure.
 - 2. Hole preparation & cleaning technique.
 - 3. Adhesive injection technique & dispenser training / maintenance.
 - 4. Rebar dowel preparation and installation.
 - 5. Proof loading/torquing.
- B. Certifications: Unless otherwise authorized by the Engineer, post-installed anchors shall have the following certification:
 - 1. ICC-ES Evaluation Report indicating conformance with current applicable ICC-ES Acceptance Criteria.

1.9 DELIVERY, STORAGE AND HANDLING

- A. General: Comply with Division 1 Section-Product Storage and Handling Requirements.
- B. Store anchors in accordance with manufacturer's recommendations.
- C. Contractor to provide the expiration date on each cartridge to the Engineer prior to use.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Hilti, Inc.
- B. Simpson Strong-Tie Company, Inc.
- C. Substitutions: None permitted.

2.2 ANCHOR TYPE

- A. Anchor types are as shown on the design drawings and/or specifications. If an anchor type is not clearly indicated, adhesive anchors shall be used.

- B. Cast-in-place anchors are required for all rotating equipment, such as pumps, blowers, compressors, centrifuges, and other like equipment.
- C. Mechanical Anchors are not acceptable for use to anchor dynamic equipment.
- D. Mechanical anchors are not acceptable for use to anchor equipment and supports which will impose sustained tension exceeding 300 lbs.
- E. Mechanical anchors are not acceptable for overhead applications which will impose sustained tension exceeding 300 lbs.
- F. Mechanical anchors are not acceptable for use to anchor into hollow core concrete panel, hollow brick, or hollow block (CMU).

2.3 MATERIALS

- A. Materials shall follow the atmospheric designations of Section 01600, unless noted otherwise on the Design Drawings. If atmosphere is not designated in Section 01600 or on the drawings, anchor material shall be AISI Type 316 stainless steel. Where materials are specifically called out, those materials are required.
- B. Anchors:
 - 1. Studs: ASTM A307; ASTM A449 where “high strength” is indicated on the Drawings.
 - 2. Carbon and Alloy Steel Nuts: ASTM A563.
 - 3. Carbon Steel Washers: ASTM F436.
 - 4. Carbon Steel Bolts and Threaded Rod: ASTM F1554 Grade 36, or ASTM F1554 Grade 55 (S1) where permitted on the Drawings.
 - 5. Wedge Anchors: ASTM A510; or ASTM A108.
 - 6. Stainless Steel Bolts, Hex Cap Screws, and Studs: ASTM F593 Group 2 (Type 316).
 - 7. Stainless Steel Nuts: ASTM F594 Group 2 (Type 316).
 - 8. Zinc Plating: ASTM B633.
 - 9. Hot-Dip Galvanizing: ASTM A153.
 - 10. Reinforcing Dowels: ASTM A615/615M.

2.4 CAST-IN-PLACE ANCHORS

- A. Neutral Atmosphere and Interior Use: Anchors, Bolts, Nuts, and Washers: Bolts and studs, nuts, and washers shall conform to ASTM F1554 Grade 36, or ASTM F1554 Grade 55 (S1), ASTM A563, and ASTM F436, as applicable. Hot-dip galvanized bolts and studs including associated nuts and washers in accordance with ASTM A153.
- B. Corrosive Atmosphere or Exterior Use: Anchors, Bolts, Nuts, and Washers: Bolts and studs, nuts, and washers shall conform to ASTM F593 Group 2 and ASTM F594 Group 2, as applicable.

2.5 POST-INSTALLED ANCHORS

- A. Wedge Anchors:
 - 1. Provide the following:

- a. Hilti Kwik Bolt TZ, ICC ESR-1917 and ESR-3785.
- b. Simpson Strong-Tie Strong-Bolt 2, ICC ESR-3037.
2. Neutral Atmosphere and Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel anchors with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1).
3. Corrosive atmosphere or Exterior Use: As indicated on the Drawings, provide stainless steel anchors. Stainless steel anchors shall be AISI Type 316 stainless. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.

B. Adhesive Anchors:

1. Provide the following, unless otherwise noted on the Drawings or Specifications:
 - a. Concrete Substrate:
 - 1) Hilti HIT-HY 200 Safe Set System, ICC ESR-3187.
 - 2) Simpson Strong-Tie SET-XP, ICC ESR-2508.
 - b. Hollow and Solid Grouted Block Substrate:
 - 1) For anchorage into hollow block, an appropriately sized screen tube shall be used per the manufacturer.
 - 2) Hilti HIT-HY 270 Safe Set System, ICC ESR-4143.
 - 3) Simpson Strong-Tie SET-XP, IAPMO-UES ER-265.
 - c. Hollow and Solid Brick Substrate:
 - 1) For anchorage into hollow brick, an appropriately sized screen tube shall be used per the manufacturer.
 - 2) Hilti HIT-HY 270 Safe Set System, ICC ESR-4134.
 - 3) Simpson Strong-Tie ET-HP, IAPMO-UES ER-241.
2. Neutral Atmosphere and Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel threaded rods conforming to ASTM F1554 Grade 36, or Grade 55 (S1) with associated nuts and washers, Hot Dipped Galvanized in accordance with ASTM A153.
3. Corrosive Atmosphere or Exterior Use: As indicated on the Drawings, provide stainless steel anchors. Stainless steel anchors shall be ASTM F593 Group 2 (Type 316) stainless steel with associated nuts and washers. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.
4. Reinforcing dowels shall be A615 Grade 60.

2.6 BONDING AGENT

- A. Shall be ready to use polyvinyl acetate resin emulsion (re-wettable) applied in accordance with manufacturer's recommendations.
1. Tamms Weld by The Euclid Chemical Company.
 2. Weld-Crete by Larsens Products Corporations.
 3. Masterprotect P 100 by Master Builders, Inc.
 4. No substitutions permitted.

2.7 NON-SHRINK NON-METALLIC GROUT

- A. Not permitted for use as anchorage material for post-installed threaded rod or reinforcement.
- B. Suitable for wet and exterior applications with a minimum compressive strength of 7,000 psi at 28-days.
1. NS Grout by The Euclid Chemical Company.

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2. Master Flow 928 by Master Builders, Inc.
3. 588-10k by W.R. Meadows, Inc.
4. Sure Grip Grout by Dayton Superior Corp.
5. L&M Crystex by Laticrete.
6. Five Start Grout by Five Star.
7. Substitutions: None permitted.

C. Prepare area, form mix and place grout in accordance with manufacturer's recommendations.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:

1. Anchors shall be set in accordance with the approved shop drawings.
2. Double nutting anchors is only allowed where shown on the drawings or where indicated on approved shop drawings.
3. The protrusion of the threaded ends through the connected material shall fully engage the threads of the nut.

B. Cast-In-Place Anchors: Use templates to locate bolts accurately and securely in formwork. Welding anchors to reinforcing steel is not permitted.

C. Post-Installed Anchors: Installed per manufacturers recommendations and instructions, supplemented with the following requirements:

1. Prior to installation, contractor to train installers using Hilt or Simpson Strong-Tie qualified training representatives.
2. Where indicated on the drawings, the Contractor shall locate and protect all reinforcing steel in substrate using non-destructive methods such as pachometer or GPR technology. Minor relocation of proposed anchors is permitted, after consult with Engineer, to avoid cutting any existing reinforcement.
3. Drill holes with rotary impact hammer drills using carbide-tipped bits, hollow drill bit system, or core drills using diamond core bits. Drill bits shall be of diameters as specified by the anchor manufacturer. Unless otherwise shown on the Drawings, all holes shall be drilled perpendicular to the concrete surface.
 - a. Cored Holes: Where anchors are permitted to be installed in cored holes, use core bits with matched tolerances as specified by the manufacturer. Properly clean cored hole per manufacturer's instructions.
 - b. Embedded Items: Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Exercise care in coring or drilling to avoid damaging existing mild, prestressed, or post-tensioned reinforcing or embedded items. Notify the Engineer if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons or utility conduits.
 - c. Base Material Strength: Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
4. Perform anchor installation in accordance with manufacturer instructions, as included in the anchor submittal.

- a. The Installer shall have tools for preparing and cleaning the hole per manufacturers recommendations readily available during installation. Tools may include but not limited to:
 - 1) Brushes.
 - 2) Vacuum.
 - 3) Air nozzles.
 - 4) Air compressor.
 - 5) Torque wrench
5. Wedge Anchors: Protect threads from damage during anchor installation. Set anchors to manufacturer's recommended torque, using a torque wrench. Following attainment of 10% of the specified torque, 100% of the specified torque shall be reached within 7 or fewer complete turns of the nut. If the specified torque is not achieved within the required number of turns, the anchor shall be removed and replaced unless otherwise directed by the Engineer.
6. Adhesive Anchors: Thoroughly clean all holes per manufacturer instructions to remove loose material and drilling dust prior to installation of adhesive. Inject adhesive into holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive. Follow manufacturer recommendations to ensure proper mixing of adhesive components. Sufficient adhesive shall be injected in the hole to ensure that the annular gap is filled to the surface. Remove excess adhesive from the surface. Shim anchors with suitable device to center the anchor in the hole. Do not disturb or load anchors before manufacturer specified cure time has elapsed.

3.2 WARM AND COLD WEATHER APPLICATIONS

- A. Observe manufacturer recommendations with respect to installation temperatures for adhesive anchors. Adhesive shall not be placed if local air or substrate temperature exceeds recommended installation temperatures.

3.3 TOLERANCE

- A. Top of anchor bolt from specified elevation or projection: $\pm 1/2$ -inch.
- B. Centerline of individual cast-in-place anchor bolt from specified location: $\pm 1/4$ -inch.
- C. Centerline of individual post-installed anchor bolt from specified location: $\pm 1/8$ -inch.

3.4 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under the provision of the Section 01400.
- B. Inspection: All anchors shall be inspected per the requirements specified in the MBC.
- C. Testing: 10% of each type and size of post-installed anchors shall be proof loaded by a third-party testing firm. Tests shall be coordinated between Contractor and Engineer and performed prior to equipment or support installation.
 1. Proof loads should be performed in accordance with ASTM E488.
 2. Proof loads shall be applied with a calibrated hydraulic ram or a calibrated torque wrench, as applicable.

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3. Adhesive anchors shall not be torque tested unless otherwise directed by the Engineer.
 4. Displacement of adhesive and capsule anchors at proof load shall not exceed $D/10$, where D is the nominal anchor diameter.
 5. Unless otherwise specified on the Design Drawings, Shop Drawings, proof loads levels shall not exceed the lesser of:
 - a. 50% of the expected peak load based on adhesive bond strength.
 - b. 80% of the anchor's minimum specified yield strength.
 6. Maintain the proof load at the required load level for a minimum of 10 seconds.
- D. If any of the tested anchors fail to achieve the specified torque or proof load within the limits as defined on the Drawings, all anchors of the same diameter and type as the failed anchor shall be tested, unless otherwise instructed by the Engineer.

3.5 REPAIR OF DEFECTIVE WORK

- A. Remove and replace misplaced or malfunctioning anchors. Anchors that fail to meet proof load or installation torque requirements shall be regarded as malfunctioning.
- B. If misplaced or malfunction anchor is to be abandoned:
 1. Remove, cut, or grind down abandoned anchor down to a minimum of 1-inch below concrete surface.
 2. Remove defective concrete down to sound concrete.
 3. Cut concrete edges perpendicular to the surface or slightly undercut to minimum depth of 1-inch. Feathered edges are not permitted.
 4. Clean surface thoroughly.
 5. Saturate patch area and surrounding 6-inches beyond patched area with water for a minimum of 3- hours.
 6. Apply bonding agent.
 7. Allow bonding agent to dry prior to placing non-shrink non-metallic grout.
 8. Point and even area with a non-shrink non-metallic grout.
 9. Strike off surface slightly higher than surrounding surface.
 10. Final finish with wood tool after lapse of 1-hour to allow initial shrinkage.
 11. Damp cure patched area for a minimum of 7-days.

END OF SECTION

SECTION 05120
STRUCTURAL STEEL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Structural steel framing members, support members suspension cables, sag rods, struts, trusses, purlins, etc.
- B. Base plates, shear stud connectors.
- C. Grouting under base plates.

1.2 RELATED SECTIONS

- A. Section 03300- Concrete Work: Supply of anchors for casting into concrete.
- B. Section 04300 - Unit Masonry System: Reinforcement, Anchoring Devices, Lintels, Bond Beams, Built-In Work cast into masonry.
- C. Section 05311 - Steel Roof Deck: Support framing for roof deck.
- D. Section 05500 - Metal Fabrications: Steel fabrications affecting structural steel work.
- E. Section 09900 – Painting: Paint finish.

1.3 REFERENCES

- A. American Institute of Steel Construction (AISC):
 - 1. Manual of Steel Construction, 14th Edition.
 - 2. AISC 303 Code of Standard Practice for Steel Building and Bridges.
 - 3. AISC 360 Specification for Structural Steel Buildings.
- B. American Society of Tests and Materials (ASTM):
 - 1. ASTM A36 Standard Specification for Carbon Structural Steel.
 - 2. ASTM A48 Standard Specification for Gray Iron Castings.
 - 3. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-dipped, Welded and Seamless.
 - 4. ASTM 108 Standard Specification Steel Bars, Carbon and Alloy, Cold Finished.
 - 5. ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 6. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 7. ASTM A240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plates, Sheets and Strips for Pressure Vessels and for General Applications.
 - 8. ASTM A242 Standard Specification for High-Strength Low-Alloy Structural Steel.

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9. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
10. ASTM A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
11. ASTM A563 Standard Specification for Carbon and Alloy Steel Nuts.
12. ASTM A572 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
13. ASTM A992 Standard Specification for Structural Steel Shapes.
14. ASTM E329 Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
15. ASTM F436 Standard Specification for Hardened Steel Washers Inches and Metric Dimensions.
16. ASTM F1554 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
17. ASTM F3125 Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel., Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Strength.

C. American Welding Society (AWS):

1. AWS A2.4 Standard Welding Symbols.
2. AWS B5.17 Qualification of Welding Fabricators.
3. AWS D1.1 Structural Welding Code – Steel.
4. AWS QC 17 AWS Accreditation of Certified Welding Fabricators.

D. SSPC – SP-3 - Steel Structures Painting Council – Painting Manual, power tool cleaning.

E. FM - Roof Assembly Classifications.

F. UL - Fire Resistance Directory.

G. Warnock Hersey - Certification Listings.

1.4 SUBMITTALS FOR REVIEW

A. Section 01300 - Submittals: Procedures for submittals.

B. Shop Drawings:

1. Indicate profiles, sizes, spacing, locations of structural members, Openings, attachments, and fasteners.
2. Connections, Fittings, clips, seats, bearing plates, stiffeners, splice material, high-tensile bolts, unfinished bolts, anchors, etc.
3. Cambers, loads.
4. Indicate welded connections with AWS A2.0 welding symbols. Indicate net weld lengths.

1.5 SUBMITTALS FOR INFORMATION

A. All shipments of material shall be accompanied by certificates from the mill stating the heat number, the chemical analysis, and physical strength tests in each shipment. These reports shall be made available to the Owner when requested.

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1.6 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Steel Fabricator:
 - a. Fabricator shall not have less than 10 years of experience in the fabrication of structural steel.
 - b. Submit a written description of the fabrication ability including facilities, personnel, and a list of similar completed projects.
 - 2. Steel Erection:
 - a. Erector shall not have less than 10 years of experience in the erection of structural steel.
- B. Fabricate structural steel members in accordance with AISC Code of Standard Practice.
- C. Perform Work in accordance with AISC 303, Section 10.
- D. Welding: All welding shall be performed by operators who have been recently qualified as prescribed in "Qualification Procedure" of the American Welding Society.
- E. Maintain one copy of each document on site.
- F. Design connections not detailed on the Drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and currently licensed in the State of Michigan. Shop drawings shall bear the seal of the Structural Engineer who designed the connections.

1.7 REGULATORY REQUIREMENTS

- A. Conform to "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings", latest edition of the American Institute of Steel Construction and governing Local or State Codes.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Structural Steel Members:
 - 1. Wide Flange Shapes – ASTM A992 ($F_y = 50$ ksi).
 - 2. Channels and Angles – ASTM A572 Gr. 50 ($F_y = 50$ ksi).
 - 3. Structural Steel Rectangular Tubing – ASTM A500 Gr. B ($F_y = 46$ ksi).
 - 4. Structural Steel Round Tubing - ASTM A500 Gr. B ($F_y = 42$ ksi).
 - 5. Structural Steel Pipe – ASTM A53 Gr. B ($F_y = 35$ ksi).
 - 6. All Other Shapes – ASTM A36 ($F_y = 36$ ksi).
- B. Headed Shear Stud Connectors: ASTM A108, Grade 1010 thru 1020.
- C. Sag Rods: ASTM A36.

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- D. Bolts, Nuts, and Washers: ASTM F3125 Gr A325 bolts, galvanized to ASTM A123, and ASTM A153 for galvanized structural members.
- E. Anchor Bolts: ASTM F1554 Gr 55 with Supplement S1 (Weldable).
- F. Welding Materials: AWS D1.1; type required for materials being welded.
- G. Grout: Non-shrink type, pre-mixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing additives, capable of developing a minimum compressive strength of 7,000 psi (48MPa) at 28 days.
- H. Painting: See Section 09900.
 - 1. Surfaces which come into permanent contact with concrete shall be left unpainted.
 - 2. Surfaces not in contact, but inaccessible after assembling either in shop or in the field shall receive two coats of primer before assembling. All other finished pieces shall be given one coat before leaving the shop. Minimum thickness of shop primer shall be 2 mils dry.
 - 3. Bolts heads, bolts, nuts, welds, and other areas left unpainted or abraded during erection shall be spot primed after erection with one coat of same paint as shop coat.
 - 4. Coordinate finish painting system under Section 09900 with primer.
 - 5. Separate dissimilar metals as specified under Section 09900.
 - 6. Prime paint one coat, ferrous surfaces, in the shop per Section 09900. Where rust spots appear on steel surface specified to be painted prior to finish coats, the surface shall be cleaned preferably with power driven tools, or with wire brush and steel wool, carefully dusted, and touched up with matching phenolic primer at the site to match adjacent shop coat.

2.2 FABRICATION

- A. Fabricate Structural Steel in accordance with the approved Shop Drawings and Reference Standards with the modifications and additional requirements in this Section.
- B. Space shear stud connectors as detailed on the drawings.
- C. Fabricate connections for bolt, nut, and washer connectors.
- D. Develop required camber for members.

2.3 PUNCHING AND DRILLING

- A. All holes for high strength bolts and unfinished bolts shall be accurately spaced and shall have a diameter 1/16 inch greater than the nominal diameter of the unit.
- B. All material 7/8 inch thick or greater, shall be drilled and not punched.
- C. Contractor shall punch holes as required for connections such as wood nailers, etc.
- D. Holes for passage of pipes and conduits shall be drilled, and reinforced as necessary, upon prior written approval of the Owner. Holes shall not be burned out.

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2.4 FIELD CONNECTIONS

- A. All field connections, except those which are specified to be welded, are to be high strength bolted.
- B. Unless otherwise noted, high strength bolts shall be governed by the current specifications for Structural Joints using current ASTM A325 bolts, A563 nuts, and F436 washers (as approved by the research Council and Riveted and bolted Joints).
- C. All joints shall be designed and executed as bearing type connections with threads excluded from the shear plane. Connections subject to stress reversal, impact and vibration, bracing, and monorail or hoist girder framing shall be designed and executed as friction-type connections.

Tightening:

- 1. For tightening of high strength bolts, Contractor shall provide compressor capable of supplying and maintaining a minimum air pressure of 100 psi. and use individual regulators in the air supply lines for each impact wrench. An approved device shall be used to establish the air pressure necessary to produce the specified minimum tension or equivalent torque on the bolt.
- 2. High strength bolts shall be tightened by calibrated wrenches or by the "Turn of the Nut" method. Impact wrenches shall be calibrated daily for the size of bolts being currently placed. All calibration shall be done with Model "M" calibrator as manufactured by Skidmore-Wilhelm Manufacturing Co., 442 Green Road, Cleveland, Ohio, for 3/4 inch and larger and of 2-1/2 inch length or longer. Only new bolts and nuts are to be used. Hardened flat washers shall be used in the calibrator, the same as in the actual structure, on the tightened side.
- 3. In lieu of the above system the tightening of high tension bolts may be accomplished by using Bethlehem Load Indicator Washers under all nuts.

Installation:

- 1. All holes shall be accurately spaced to allow insertion of high strength bolts 1/16 inch smaller than the hole diameter. Before the final tightening of a joint, the several parts of a joint shall be properly assembled to a snug tight condition. This condition may be obtained by using the high strength bolts for this purpose without the use of erection bolts, if so desired.
- 2. Slotted holes may be used in field connections for temperature corrections provided these connections are approved by the Owner before fabrication. All temperature correction joints shall be indicated on the shop drawings.
- 3. No individual piece of structural steel shall have less than two high strength bolts connecting it to any other member.
- 4. High strength bolts shall not occur where they interfere with the placing of grating, roof, and/or floor decking.
- 5. Contact surfaces of all high strength bolted joints shall be cleaned of all defects that would prevent solid seating of the parts. Faying surfaces of high strength bolted field joints employing friction type bolts shall be kept free of paint.
- 6. After completing each connection having more than four bolts, the contractor is to recheck each bolt in the connection and retighten all bolts in the connection when rechecking indicates the joint does not conform to the Specification.

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7. The Contractor shall furnish all labor necessary in connection with inspection of joints, to the complete satisfaction of the Owner, and shall assume full responsibility for the cost and delay of correcting connections that are found unsatisfactory.

2.5 FINISH

- A. Prepare structural component surfaces in accordance with SSPC SP-3. Where galvanized surfaces are to receive painted finish, prepare surface in accordance with Section 09900.
- B. Shop prime structural steel members. Do not prime surfaces that will be fireproofed, field welded, in contact with concrete, and high strength bolted.
- C. Galvanize all structural steel members and miscellaneous steel items (unless specifically noted otherwise on the Drawings or in the Specifications) to ASTM A123. Provide minimum 2.0 oz/sq ft of surface area of galvanized coating.
- D. Hardware: Hot dip in accordance with ASTM A153.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01039 - Coordination and Meetings: Verification of existing conditions prior to beginning work.

3.2 ERECTION

- A. Allow for erection loads, and for sufficient temporary bracing to maintain structure safe, plumb, and in true alignment until completion of erection and installation of permanent bracing.
- B. Field weld components as indicated on Drawings.
- C. Field connect members with threaded fasteners; torque to required resistance.
- D. Do not field cut or alter structural members without approval of Engineer.
- E. After erection, prime welds, abrasions, and surfaces not shop primed, or galvanized, except surfaces to be in contact with concrete.
- F. Grout under base plates in accordance with Section 05120-2.01. Trowel grouted surface smooth, splay neatly to 45 degrees.
- G. Unless otherwise shown, field connections shall be made with not less than 3/4" diameter high strength bolts.
- H. All connections are to be symmetrical. One sided connections shall require specific approval by the Owner. At skewed connections, bend angles and other material carefully, if necessary, in heated condition, to avoid cracking and other damage to member.

- I. Where connections are not detailed on the Drawings, the connection shall be selected from AISC Manual of steel Construction, Part 4, Framed Beam connections to support not less than the reaction of the uniform load capacity of each particular beam or girder in relation to its size and span. In addition, the connection, whether bolted or welded, shall in no case be less than 1/2 of the maximum shear capacity of the member and the welds of welded connections shall be spread over not less than 1/2 of the depth of the member.
- J. Connections of tension members or tensile splices shall develop the forces based on the net cross section, unless otherwise noted.
- K. Connections of compression members and compression splices shall be designed under consideration of the governing slenderness ratio. Compression splices shall be placed only at or near places of lateral support.
- L. Flexural splices shall develop the section modules of the spliced member unless otherwise noted.

3.3 ERECTION TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch (6 mm) per story, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch (6 mm).

3.4 FIELD QUALITY CONTROL

- A. Section 01400 - Quality Control: Field inspection, testing of bolt torquing, welds, torquing of fasteners, in addition to the following;
 - 1. Contractor to test between 5 % & 10 % of the bolts in the presence of the Owner's designated Resident Engineer. Bolts to be tested will be selected at random by the Owner's designated resident Engineer.
 - 2. Owner reserves the option to provide and pay for a qualified inspector to check additional connections, as he may desire.
 - 3. Torque wrenches used, shall be calibrated daily.
 - 4. Contractor shall inform the Owner as to when he desires connections checked, and shall make every effort to coordinate erection work with field inspection. The checking should be done without delay after bolts are in place and should continue together with and at the same rate as the bolting up process so that possible necessary corrective measures can be taken immediately. If siding, concrete, roof decking or other equipment interferes with the inspectors checking a connection, the Contractor at his own expense shall remove and replace the interfering object to allow the inspector to check the connection.
 - 5. Contractor shall furnish a man to go with and aid the inspector during the checking process and shall provide all labor necessary to loosen and retighten bolts to the satisfaction of the inspector.
 - 6. After loosening a bolt, it is recognized that less torque will be required to tighten the same bolt to the specified tension. Therefore, the calibration of impact wrenches for retightening purposes shall be done separately and the wrenches for retightening shall be kept separate from the ones used for the original tightening.
 - 7. In the event any bolt in connection is found not to have the required tension, all bolts in that connection shall be tested, and any bolts not meeting specifications shall be

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further tightened. If proper tension cannot be reached by further tightening, the bolts shall be replaced in their entirety with new bolts, nuts, and washers and properly tightened.

8. The Owner's checking of connections does not relieve the Contractor of the responsibility of any faulty connection.
9. All material to be furnished shall be subject to inspection and test in the shop and field by inspectors assigned and contracted by the Owner.
10. Inspection and tests will be conducted without expense to the Contractor. However, inspection by the Owner's designated representative will not relieve the Contractor of the responsibility to furnish satisfactory materials. When materials and workmanship do not conform to the specification requirements, the Owner reserves the right to reject material or workmanship or both at any time before final acceptance of the structure.

END OF SECTION

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SECTION 05500

METAL FABRICATIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Shop fabricated ferrous metal items, including but not limited:
 - 1. Miscellaneous steel lintels, steel plate fabrications, beams, angles, and channels.
 - 2. Effluent weir trough construction.
 - 3. Bar Screens and Bar Screen Rake.
 - 4. Stop Plates with Grooves.
 - 5. Platforms.
 - 6. Building interior access manhole covers and frames.
 - 7. Guardrail Closure Gates.

1.2 RELATED SECTIONS

- A. Section 03300 - Concrete Work: Placement of metal fabrications in concrete.
- B. Section 04300 - Unit Masonry System: Placement of metal fabrications in masonry.
- C. Section 06110 - Glass Fiber and Resin Fabrications.
- D. Section 09900 - Painting: Paint finish.

1.3 REFERENCES

- A. American Institute of Steel Construction (AISC):
 - 1. Manual of Steel Construction, 14th Edition.
 - 2. AISC 303 Code of Standard Practice for Steel Building and Bridges.
 - 3. AISC 360 Specification for Structural Steel Buildings.
- B. American Society of Tests and Materials (ASTM):
 - 1. ASTM A36 Standard Specification for Carbon Structural Steel.
 - 2. ASTM A48 Standard Specification for Gray Iron Castings.
 - 3. ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 4. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 5. ASTM A240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plates, Sheets and Strips for Pressure Vessels and for General Applications.
 - 6. ASTM A276 Standard Specification for Stainless Steel Bars and Shapes.
 - 7. ASTM A283 Standard Specification for Low and Intermediate Strength Carbon Steel Plates.
 - 8. ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength.

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9. ASTM A312 Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipe
 10. ASTM A320 Specification for Alloys-Steel and Stainless Steel Bolting for Low-Temperature Service.
 11. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
 12. ASTM A554 Standard Specification for Welded Stainless Steel Mechanical Tubing
 13. ASTM A563 Standard Specification for Carbon and Alloy Steel Nuts.
 14. ASTM A572 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
 15. ASTM A653 Standard Specification for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 16. ASTM A992 Standard Specification for Structural Steel Shapes.
 17. ASTM B85 Standard Specification for Aluminum-Alloy Die Castings.
 18. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 19. ASTM B210 Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes.
 20. ASTM B211 Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.
 21. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 22. ASTM E329 Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
 23. ASTM F436 Standard Specification for Hardened Steel Washers Inches and Metric Dimensions.
 24. ASTM F3125 Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel., Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Strength.

C. American Welding Society (AWS)

1. AWS A2.4 Standard Welding Symbols.
2. AWS B5.17 Qualification of Welding Fabricators.
3. AWS D1.1 Structural Welding Code – Steel.
4. AWS D1.2 Structural Welding Code – Aluminum.
5. AWS D1.3 Structural Welding Code – Sheet Steel.
6. AWS D1.6 Structural Welding Code – Stainless Steel.
7. AWS QC 17 AWS Accreditation of Certified Welding Fabricators.

D. SSPC - Steel Structures Painting Council.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
- C. Prepare Shop Drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State of Michigan.

- D. Indicate welded connections using standard AWS A2.4. Indicate net weld lengths.
- E. Welding certificates.
- F. Product Data: Provide high strength bolt test data, details of product descriptions, product limitations.

1.5 QUALIFICATIONS

- A. Fabricator shall be experienced in producing metal fabrications similar to those indicated in the Section and on the Contract Drawings, with a minimum of ten (10) years of documented experience, as well as sufficient production capacity to produce required units.
- B. Licensed Professional Engineer: A registered Professional Engineer qualified and experienced in structural engineering shall be engaged to prepare design drawings, calculations, and all other related structural data.
 - 1. The selected Professional Structural Engineer shall have designed a minimum of ten (10) projects similar to those indicated in this Section and on the Contract Drawings, with a minimum of five (5) years of documented experience.
 - 2. The selected Professional Structural Engineer shall submit a list containing the project names, locations, Owners and telephone numbers with contact names, along with dates of start and completion and description of overall size.
 - 3. The selected Professional Structural Engineer shall be currently registered in the State of Michigan and the drawings and calculations submitted shall be signed and sealed.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel to the applicable AWS Code. Certify that each welder employed on the Work has completed and passed AWS qualification tests for welding processes involved. Fabricator certification based on AWS B5.17 and AWS QC 17.
- B. Verify that field measurements are as indicated on shop drawings and instructed by the manufacturer.

1.7 REGULATORY REQUIREMENTS

- A. Conform to "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings", latest edition of the American Institute of Steel Construction and governing Local or State Codes.
 - 1. Michigan Building Code, Latest Edition.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Steel
 - 1. Structural Shapes: ASTM A992.
 - 2. S-Shapes: ASTM A36
 - 3. Angles, Bars, Channels and Steel Plate: ASTM A572 Grade 50.

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4. Hollow Structural Sections: ASTM A500, Grade B.
5. Steel Pipe: ASTM A500, Grade B.
6. Sheet Steel: ASTM A653, Grade 33 Structural Quality, galvanized with 1.5-ounce coating class.
7. Bolts: ASTM F3125 Grade A325; Type 1.
 - a. Finish: Hot dipped galvanized.
8. Nuts: ASTM A563 heavy hex type.
 - a. Finish: Hot dipped galvanized.
9. Washers: ASTM F436; Type 1.
 - a. Finish: Hot dipped galvanized.
10. Welding Materials: Per the applicable requirements of AWS D1.1 and AWS D1.3; type required for materials being welded.
11. Coating: Hot dipped galvanized after fabrication per ASTM 123.
12. Touch-Up Primer for Galvanized Surfaces: In accordance with requirements of Specification Section 09900.

B. STAINLESS STEEL

1. Bars and Shapes: ASTM A276; Type 316 (U.N.O).
2. Tubing – Square and Rectangular: ASTM A554; Type 316 (U.N.O).
3. Tubing – Round: ASTM A312 seamless; Type 316 (U.N.O).
4. Pipe: ASTM A312 seamless; Type 316 (U.N.O).
5. Plate, Sheet and Strip: ASTM A240 OR ASTM 666; Type 304 (U.N.O).
6. Bolts, Nuts, and Washers: Stainless Steel Bolts: Conform to ASTM A320, Grade B8M (AISI Type 316, U.N.O.).
7. Welding Materials: AWS D1.6; type required for materials being welded.
8. Stainless Steel Bolts: Conform to ASTM A320, Grade B8M (AISI Type 316, U.N.O.).

C. ALUMINUM

1. Extruded Aluminum: ASTM B221 Alloy 6063, Temper T5.
2. Sheet Aluminum: ASTM B209, Alloy 6061.
3. Aluminum-Alloy Drawn Seamless Tubes: ASTM B210, Alloy 6063, Temper T6.
4. Aluminum-Alloy Bars: ASTM B211, Alloy 6063, Temper T6.
5. Aluminum-Alloy Sand Castings: ASTM B26/B26M.
6. Aluminum-Alloy Die Castings: ASTM B85, Alloy as required to suit application.
7. Bolts, Nuts, and Washers: Stainless steel.
8. Welding Materials: AWS D1.2; type required for materials being welded.

2.2 MISCELLANEOUS MATERIALS

A. Headed Steel Anchor Studs: Conform to ASTM A108, Grades 1010 through 1020 (UNS G10100 through G10200) as manufactured by:

1. Erico Products, Inc. - "Blue Arc" Type HA.
2. KSM Products - Headed Concrete Studs."
3. TRW Nelson Division - Concrete Anchors.

B. Steel Guardrail Access Gates:

1. Gates shall be self-closing and sized as shown on the Drawings.
2. For gates not indicated, provide size #21 (fit clear opening 22" - 24-1/2"), as manufactured by FabEnCo, Inc., 2021 Karlback, Houston, Texas, 77092.
3. Gates shall be furnished with all hardware necessary for mounting to guardrails as detailed.

4. Gate material shall be stainless steel, type 316L.
- C. Abrasive Stair Nosings:
1. Abrasive stair nosings shall be abrasive cast aluminum construction. Nosings shall be Wooster Products, Model No. 101 or other Engineer approved equal nosing.
 2. Nosings shall be 3" deep and stair width less 3", flush with concrete all around, and anchored with wing style anchors.
- D. Climbing Assist: Telescoping safety post shall be provided on all ladders that are accessed through a hatch located in a horizontal surface.
1. The safety post shall be the type that can be extended above the hatch cover when the hatch is open to assist personnel, and retractable to original position for closing hatch.
 2. Safety post mounts to the center of the ladder.
 3. Device shall be constructed of type 304 stainless steel.
 4. Device shall be Bilco "Ladder-Up" Safety Device or other Engineer approved equal.
- E. Welding Materials: Per applicable welding code.
- F. Touch-Up Primer for Galvanized Surfaces: Per Section 09900.

2.3 FABRICATION

- A. Fabricate Structural Steel in accordance with the approved Shop Drawings and Reference Standards with the modifications and additional requirements in this Section.
- B. Fit and shop assemble in largest practical sections, for delivery to site.
- C. Fabricate items with joints tightly fitted and secured.
- D. Continuously seal joined members exposed to weather, by continuous watertight welds, ground smooth.
- E. Grind exposed welds and joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- F. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- G. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
- H. Bolt heads, where required, shall be countersunk flush with the surface of the members in which they are located.
- I. No shop or field burning is permitted without the permission of the Owner. If permission is given, all burned members shall be finished to an acceptable appearance which shall be the equal of a sheared finish.

- J. Structural shop connections shall be welded or bolted with high tensile bolts. Initial shop bolting, when used, shall be for erection purposes only.
- K. Final torque all shop and field bolted connections in the field to provide unit connections.
- L. All bolted connections shall be made with not less than two, 3/4 inch minimum diameter, high strength bolts.
- M. All connections shall be symmetrical.
- N. Effluent Weir Troughs - (In addition to above listed fabrication requirements):
 - 1. No field welding permitted.
 - 2. All lockwashers, nuts, bolts, expansion anchors, threaded weld studs and washers to be Type 304 stainless steel, (U.N.O.).
 - 3. All welds continuous and watertight.
 - 4. Apply anti-seize compound to all threaded parts prior to installing washers and nuts.
 - 5. Provide neoprene gaskets (40 durometer, typ.) compresses to 3/8 inch thick at each side and bottom; neoprene 1/2 inch pads at underside of trough at wall pocket; 5/16 inch continuous neoprene gasket compressed to 1/4 inch at trough splice, (both sides and bottom); 1/4 inch x 5 inch continuous neoprene gasket with additional end pieces at FRP weir adjustment plates.
 - 6. At radius outside bottom corners of trough install joint filler with elastomeric sealant to complete watertight seal.
 - 7. Protect all neoprene gaskets and pads from direct sunlight; protect all edges with elastomeric sealant.

2.4 FINISHES

- A. Prepare surfaces to be primed in accordance with Specification Section 09900 - PAINTING.
- B. Do not prime surfaces in direct contact with concrete or where field welding is required.
- C. Prime paint items with one coat as specified in Section 09900.
- D. Fabricated Items: Galvanize in accordance with ASTM A123, structural steel members. Provide minimum 2 oz/sq ft galvanized coating. Effluent weir trough, checkered plate covers and frame assemblies shall be galvanized after fabrication.
- E. Hardware: Hot dip in accordance with ASTM A153.
- F. Cadmium Plated Items: (When Owner permitted), provide in accordance with ASTM A165 Type N.S.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.
- B. Beginning of installation means erector accepts existing conditions.

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3.2 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Supply items required to be cast into concrete or embedded in masonry with setting templates, to appropriate sections.

3.3 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Field weld components indicated on shop drawings.
- D. Perform field welding in accordance with the applicable AWS code.
- E. Obtain Engineer approval prior to site cutting or making adjustments not scheduled.
- F. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.4 SCHEDULE

- A. The Schedule is a list of principal items only. Refer to Drawing details for items not specifically scheduled.
- B. Headed Steel Anchor Studs: Size and length as indicated on the Drawings.
- C. Ledge, Shelf, Lintel Angles; Channels and Plates (Including Effluent Weir Trough Construction): Fabricate as shown on the Drawings; galvanize all material, unless specifically noted otherwise.
- D. Hoist Beams, Shim plates, Stops and Accessories: Size as shown on the Drawings; prime painted steel in Dry Well, galvanized finish in Wet Well.
- E. Miscellaneous Steel Beams, Channel and Plate Fabricated Supporting Members: Size and fabrication as shown on the Drawings. Galvanize all members in Wet Well and Fan Room.
- F. Access gates at openings for ladders; coordinate with guardrail. Rail manufacturer shall coordinate installation location and provide any special internal reinforcing of the rail system to accommodate the gate.
- G. Expansion Anchors: When not shown on the Drawings, anchors shall be Red Head Wedge Anchors or Parabol; minimum 4 inch long concrete embedment.
- H. Material specified herein shall be finish painted as specified in Section 09900; stainless steel and FRP items shall not be painted.

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- I. Stop plates with grooves: Fabricate as shown on the Drawings. Galvanize all items unless specifically noted otherwise.
- J. Checkered plate covers and frames: Fabricate as shown on the Drawings. Galvanize all items unless specifically noted otherwise.
- K. Bar Screens: Fabricate as shown on the Drawings. Galvanize all items unless specifically noted otherwise.
- L. Bar Screen Rake: Fabricate as shown on the Drawings. Galvanize after fabrication.
- M. Decant Intake Screen: Fabricate as shown on the Drawings. Galvanize all items after fabrication unless specifically noted otherwise.

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SECTION 05525

ALUMINUM HANDRAILS AND GUARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Furnish and install aluminum guard and handrailing system and fittings, as shown on the Drawings. Railings include but are not limited to:
 - 1. Railings on open side(s) of stairs shall be handrail/guardrail combination as detailed.
 - 2. Handrails shall be provided on both sides of stairs whether stair has accompanying guardrail on the open side.
- B. Guardrails for equipment platforms and tank walkways shall be as shown on the Drawings and specified herein.
- C. New installed system shall match existing system installed as close as practical in profile and configuration.

1.2 RELATED SECTIONS

- A. Section 07900 – Joint Sealers: Sealant around handrail system posts.

1.3 REFERENCES

- A. AA ADM 1 – Aluminum Design Manual.
- B. ADA – Americans With Disabilities Accessibility Standards.
- C. American Welding Society (AWS):
 - 1. AWS B5.17 Qualification of Welding Fabricators.
 - 2. AWS D1.2 Structural Welding Code-Aluminum.
 - 3. AWS QC 17 AWS Accreditation of Certified Welding Fabricators.
- D. American Society for Testing and Materials (ASTM):
 - 1. ASTM B26 Aluminum-Alloy Sand Castings.
 - 2. ASTM B211 Aluminum-Alloy Bars, Rods, and Wire.
 - 3. ASTM B221 Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
 - 4. ASTM B241 Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.
 - 5. ASTM B427 Aluminum and Aluminum Die Forgings, Hand Forgings and Rolled Ring Forgings.
 - 6. ASTM B429 Aluminum-Alloy Structural Pipe and Tube
 - 7. ASTM B483 Aluminum and Aluminum-Alloy Drawn Tubes for General Purpose Applications.
 - 8. ASTM E935 Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.
- E. NAAMM – National Association of Architectural Metal Manufacturers.

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F. SSPC (Steel Structures Painting Council) - Steel Structures Painting Manual.

1.4 DESIGN REQUIREMENTS

A. Railing assemblies, wall rails, and attachments shall be designed to meet the configuration and loading requirements of MIOSHA and from the latest State of Michigan Building Code without damage, permanent set or exceeding the allowable design working stress of the materials for the handrails, railing systems, anchors, and connections.

1. Test in accordance with ASTM E935.
2. Live load reduction and load sharing are not permitted.

B. Connections and Anchorage:

1. Bolted connections utilizing stainless steel bolts are required.
2. Connection to concrete structure shall utilize post-installed adhesive anchors. Mechanical anchor and embedded posts are not permissible.
3. Welded connections are permitted. The allowable stress of the welded aluminum structure shall be reduced within the welded zone. Refer to AA ADM 1 for additional requirements.

C. Allow for thermal action from a maximum range in ambient temperatures in the design, fabrications and installation of the railing system to prevent opening of joints, buckling, and other detrimental effects including over-stressing of connections and components.

D. Prevent galvanic action and other forms of corrosion by isolating dissimilar metals, preventing direct contact with each other. See Section 09900 for back-coating aluminum materials.

E. Provide guardrail/handrail system and component parts from one source to assure consistency in quality and appearance.

F. Guardrail/handrail system shall be fabricated and delivered to the site in the largest sections practical to minimize the number of field joints.

1.5 SUBMITTALS FOR REVIEW

A. Section 01300 - Submittals: Procedures for submittals.

B. Shop Drawings: Show complete layout, plan view, elevations, connections, details for fabrication and attachment to other elements and other installation details.

C. Include calculations signed and sealed by the Registered Professional Engineer currently licensed in the State of Michigan who is responsible for the structural design of the railing system.

D. Welding Certifications: Manufacture certification based on AWS B5.17 and AWS QC 17.

E. Test Reports: Structural performance evaluation of railing systems in accordance with the following criteria:

1. ASTM E935, Latest Edition.
2. ICC-ES AC273, Latest Edition – Acceptance criteria for Handrails and Guards, for the following building codes:

- a. Michigan Building Code, latest edition

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in protective packaging to avoid damage or staining of the materials and finishes.
- B. Store materials properly and in accordance with the manufacturer's recommendations to avoid damage from moisture, abrasion and other construction activities.
- C. Avoid excessive handling of materials at the job site.

1.7 QUALITY ASSURANCE

- A. **Welding Standards:** Qualify procedures and personnel to the applicable AWS Code. Certify that each welder employed on the work has completed and passed AWS qualification test for welding processes involved.
- B. **Single-Source Responsibility:** Obtain handrails, guardrails, fittings, connectors, base plates, accessories and appurtenances of each type and material from a single manufacturer.

1.8 SITE CONDITIONS

- A. **Field Measurements:** Where handrails and guard rail systems are indicated to fit to other construction, check actual dimensions of other construction by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. **Manufacturers**
 - 1. Golden Railings, Inc. – Bolted System or Welded Handrail System
 - 2. Julius Blum & Co., Inc. – Connectorail® System
 - 3. Kane Innovations, Inc.; Sterling Dula Architectural Products – Pipe Rail System
 - 4. Superior Aluminum Products Inc. – Series 500 System
- B. **Substitutions:** None permitted.

2.2 MATERIALS

- A. **Aluminum**
 - 1. Extruded tubing or pipe: ASTM B221 - Alloy 6061-T6 or Alloy 6063-T4, T5, T52 or T6.
 - 2. Extruded Reinforcing bars: ASTM B221– Alloy 6061-T6 or T5.
 - 3. Aluminum-Alloy Drawn Seamless Tubes: ASTM B210, Alloy 6063, Temper T6.
 - 4. Stamped Die and Hand Forgings: ASTM B247
 - 5. Extruded bars, shapes and moldings: ASTM B221– Alloy 6063-T52.

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- 6. Fasteners – Series 300 stainless steel.

2.3 ALUMINUM RAILING SYSTEM

- A. Rails: Nominal 1-1/2 inch (38 mm) minimum diameter, schedule 80 (min) aluminum pipe.
- B. Posts: Nominal 1-1/2 inch (38 mm) minimum diameter, schedule 80 (min) aluminum pipe.
- C. Fittings: Elbows, T-shapes, brackets, etc., aluminum – flush with rail system.
- D. Mounting:
 - 1. Brackets, post receiver and flanges from same material as railing system. Provide side mount/fascia flanges for mounting to steel walkway or concrete as detailed on the Drawings.
 - 2. Posts - Heavy duty floor flanges (similar to Julius Blum & Co. No. 7471/7571 as applicable for pipe size to be provided.)
 - 3. Base plates- welded baseplates permitted provided calculations support design requirement criteria and account for strength reduction of the welded aluminum structure within the welded zone. Refer to AA ADM 1 for additional requirements.
- E. Splice Connectors: Concealed, non-welded, aluminum – clear anodized finish. Exposed connectors are not permitted. Railing surface shall be smooth, continuous through the use of concealed splice connectors.
- F. Exposed Fasteners: Flush countersunk screws or bolts; consistent with design of railing.
- G. Toe Board: Extruded aluminum, channel shape or fabricated with stiffening ribs – flat aluminum stock is not acceptable.
- H. Aluminum Surfaces: Clear anodized AA-M10-C22-A31.
- I. Apply one coat of back-coat material per Section 09900 to concealed aluminum surfaces in contact with cementitious or dissimilar materials.

2.4 FABRICATION

- A. Fabricate railing system to comply with the manufacturer’s printed requirements, project design requirements, details, dimensions, finish, member sizes, including post spacing and anchorage, but not less than the structural requirements to support loading.
- B. In no case shall post spacing exceed 6’ - 0” between members.
- C. Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.
- D. Factory joints shall be coped and tig-welded by certified welders (AWS D1.2). Welds to be ground smooth prior to finishing.
- E. Field welding is not permitted.

- F. Provide anchors, required for connecting railings to structure.
- G. Exposed Mechanical Fastenings and Connectors: Mechanical connectors may be used; provide flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- H. Supply components required for anchorage of fabrications. Anchors shall be Series 300 stainless steel, unless noted otherwise on the Drawings.
- I. Assemble exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- J. Accurately form components to each other and to building structure.
- K. Employ smooth curves by using radius elbows as opposed to mitering and welding.
- L. Use appropriate end caps to close exposed open ends of all pipes. End cap material shall match railings.
- M. Accommodate for expansion and contraction of members and building movement without damage to connections or members. For railings along elevated steel walkways, coordinate railing expansion joints to accommodate walkway expansion joints as required by the railing system manufacturer.
- N. Provide weep holes or other means to exit water from hollow sections of the railing members, exposed to the exterior, condensation or moisture from other sources.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine system components, substrate and conditions where railing system is to be installed.
- B. Notify Engineer in writing of any unsatisfactory conditions prior to starting any of the work.

3.2 PREPARATION

- A. Prepare surrounding construction to receive railing system installations to comply with the manufacturer's printed instructions.
- B. Review and coordinate setting drawings, shop drawings, templates, and instructions for assembly and installation of the railing system and related items to be embedded in concrete or masonry.

3.3 INSTALLATION

- A. Install components plumb and level, accurately fitted, free from distortion or defects.
- B. Conceal bolts and screws whenever possible.

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- C. Assemble railing system accommodate tight joints and secure installation.
- D. Immediately upon completion of the installation clean all surfaces with clean water and a mild soap or detergent and rinse with clean water.
- E. Do not use acid solution, steel wool, or abrasives.

3.4 ERECTION TOLERANCES

- A. Maximum Variation from Plumb: 1/4 inch.
- B. Maximum Offset from True Alignment: 1/4 inch.
- C. Maximum Out-of-Position: 1/4 inch.

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SECTION 05531
ALUMINUM GRATINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Formed aluminum swaged gratings and miscellaneous accessories as shown on the Contract Drawings including architectural (A), structural (S), and process (P) sheets.

1.2 REFERENCES

- A. ASTM B 221 Aluminum Extruded Bars and Shapes
- B. ANSI/NAAMM- MBG-531-09 Metal Bar Grating Manual
- C. ANSI-NFSI B101.3-2012 Test Method for Measuring Wet Dynamic Coefficient of Friction (Wet DCOF) of Common Hard-Surface Floor Materials
- D. ANSI/AWS A2.4 - Standard Symbols for Welding, Brazing and Nondestructive Examination.
- E. ANSI/AWS D1.1 - Structural Welding Code, Steel.

1.3 PERFORMANCE REQUIREMENTS

- A. Load Design: Conform to ANSI/NAAMM MGB 531-09, ANSI/NAAMM MBG 532 for grating type shown on the Drawings.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Shop Drawings: Indicate details of component supports, openings, perimeter construction details, and tolerances.
- C. Indicate welded connections using standard ANSI/AWS A2.4 welding symbols. Indicate net weld lengths.
- D. Product Data: Provide span and deflection tables.
- E. Samples: Submit two samples, 6 x 6 inch in size illustrating surface finish, color, and texture.
- F. Manufacturer's Installation Instructions: Indicate special requirements of opening, perimeter framing, etc.

1.5 QUALIFICATIONS

- A. Design gratings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State of Michigan.

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- B. Welders' Certificates: Submit under provisions of Section 01300, certifying welders employed on the Work, verifying AWS qualification within the previous 12 months.

1.6 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings.

1.7 COORDINATION

- A. Coordinate work under provisions of Section 01039.
- B. Coordinate the work with placement of frames, tolerances for placed frames, and openings.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. IKG Borden, Type BS
- B. Ohio Gratings, Type 19-SG-4
- C. Barnett Bates, Type 19-AP-4
- D. Klemp Grating, Type KRP-19-4
- E. Substitutions: Under provisions of Section 01300.

2.2 GENERAL

- A. Provide shop-fabricated grating and accessories including frames, support angles, fasteners, and treads.
- B. Treads and exposed edges of grating platforms shall be corrugate or cast aluminum abrasive nosing.
- C. Grating Products shall be designed and manufactured to meet the live load conditions of 100 lbs/ Sq Ft with maximum deflection of 1/4" for the clear spans shown on the drawings. Bearing bar depth shall be as shown on the contract drawings or as recommended by the manufacturer to meet the loading requirements, clear span conditions and maximum deflections specified.

2.3 MATERIALS

- A. Grating and Treads: Serrated aluminum, alloy 6061-T6 or 6063-T6 rectangular shape.
- B. Cross Bars: Alloy 6061-T6 or 6063-T6; rectangular shape.
- C. Welding Materials: ANSI/AWS D1.2; type required for materials being welded.
- D. Cross bars: spaced on 4 inch on center

- E. Bearing bars: spaced on 1-3/16 inches on center.
- F. Size bearing bars as follows, unless otherwise noted on the drawings:

Clear Span, Maximum	Bearing Size
3'-8"	1-1/4" x 1/8"
4'-2"	1-1/4" x 3/16"
4'-5"	1-1/2" x 1/8"
5'-0"	1-1/2" x 3/16"
5'-10"	1-3/4" x 3/16"
6'-2"	2" x 3/16"
6'-10"	2-1/4" x 3/16"
7'-8"	2-1/2" x 3/16"

2.4 ACCESSORIES

- A. Fasteners and Saddle Clips: Materials and coatings to match grating. Provide fastening devices to firmly anchor gratings and treads. Sections designated as removable shall not be attached to supports.
 - 1. Minimum 4 per panel.
 - 2. Shall allow for repeated removal.
 - 3. Saddle clip, "G" clip type, or Clamp type.
 - 4. Minimum 1/4" bolts or self-tapping screws.
 - 5. 316 stainless steel.
- B. Perimeter Banding: All removable sections of grating shall be banded with same material as grating. Additional grating may also require banding when shown on the Drawings as banded.
 - 1. Bearing bars not resting on supports shall have load carrying banding sized to span opening.
 - 2. Minimum banding thickness shall match bearing bar thickness.
 - 3. Banding shall be flush with top of grating.
 - 4. Banding depth shall be 1/4" less than bearing bar depth at supports.

2.5 FABRICATION

- A. Fabricate grates to sizes indicated.
- B. Weld joints of intersecting sections.
- C. Fabricate support framing for openings as shown on the Drawings.
- D. Top Surface: Manufacturer's standard, unless noted otherwise on the Drawings.

2.6 FINISHES

- A. Gratings shall be A-41 Clear Anodized.

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PART 3 EXECUTION

3.1 EXAMINATION

- A. Take field measurements prior to preparation of final shop drawings and fabrication where required to ensure proper fitting of the work.
- B. Verify that opening sizes and dimensional tolerances are acceptable.
- C. Verify that supports and anchors are correctly positioned.

3.2 INSTALLATION

- A. Install components in accordance with manufacturer's instructions and as recommended by ANSI/NAAMM MBG-531-09 Metal Bar Grating Manual.
- B. Prior to grating installation, contractor shall inspect supports for correct alignment and conditions for proper attachment and support of the gratings. Any inconsistencies between contract drawings and supporting structure deemed detrimental to grating placement shall be reported in writing to the Engineer prior to placement.
- C. Place frames in correct position, plumb and level.
- D. Mechanically cut galvanized finish surfaces. Do not flame cut. Touch-up all abraded, cut surfaces with cold galvanizing compound.
- E. Install all grating complete with accessory fittings to meet Owner approval
- F. Anchor grating in place as detailed on the Drawings. As a minimum install saddle clips at each support at 2'-0" spacing, minimum 2 per edge. Use 1/4" diameter studs or bolts with washers.
- G. Protection of Aluminum from Dissimilar Materials:
 - 1. Where aluminum surfaces come into contact with dissimilar metals, surfaces shall be kept from direct contact by painting the dissimilar metal with one coat of bituminous paint or use of other approved insulating material.
 - 2. Where aluminum surfaces come into contact with dissimilar materials such as concrete, masonry or lime mortar, exposed aluminum surfaces shall be painted with one coat of bituminous paint or use of other approved insulating material.
- H. Set perimeter closure flush with top of grating and surrounding construction.
- I. Secure to prevent movement.

END OF SECTION

SECTION 06114

WOOD BLOCKING AND CURBING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wood blocking for miscellaneous supports.
- B. Preservative treatment of wood. Wood used in conjunction with re-roofing activities shall have preservative treatment approved for use by the Approved Roofing System Manufacturer, for use with their single-ply membrane system.

1.2 REFERENCES

- A. ALSC - American Lumber Standards Committee: Softwood Lumber Standards.
- B. AWWPA (American Wood Preservers Association) U1 – User Category System.
- C. AWWPA (American Wood Preservers Association) C20 - Structural Lumber Fire Retardant Treatment by Pressure Process.
- D. NFPA: National Forest Products Association.
- E. SPIB: Southern Pine Inspection Bureau.
- F. WCLIB: West Coast Lumber Inspection Bureau.
- G. WWPA: Western Wood Products Association.

1.3 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide technical data on wood preservative materials and application instructions.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with the following agencies:
 - 1. Lumber Grading Agency: Certified by ALSC.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Lumber Grading Rules: NFPA.

- B. Miscellaneous Framing: Stress Group D, No. 2 Southern Pine or No. 2 Douglas Fir, 19 percent maximum moisture content, pressure preservative treat.

2.2 ACCESSORIES

- A. Fasteners and Anchors:
 - 1. Fasteners: Hot-dipped galvanized steel for wood locations, unless noted otherwise.
 - 2. Anchors: Hot-dipped Galvanized; Toggle bolt type for anchorage to hollow masonry; Expansion shield and lag bolt type for anchorage to solid masonry or concrete; Bolt or ballistic fastener for anchorages to steel. Note – anchors shall be suitable for use with ACQ treated lumber.

2.3 FACTORY WOOD TREATMENT

- A. Wood preservative:
 - 1. All materials shall be pressure treated to meet AWPA UC3B with .25 pounds per cubic foot, minimum retention, of Alkaline Copper Quat (ACQ).

PART 3 EXECUTION

3.1 FRAMING

- A. Set members level and plumb, in correct position.
- B. Place horizontal members flat, crown side up.

3.2 SITE APPLIED WOOD TREATMENT

- A. Apply preservative treatment in accordance with manufacturer's instructions.
- B. Brush apply two coats of preservative treatment on wood where ends have been field cut for erection.
- C. Allow preservative to dry prior to erecting members.

END OF SECTION

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SECTION 06610

GLASS FIBER AND RESIN FABRICATIONS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install all fiberglass items as specified herein and as shown on the Drawings. The Contractor shall be responsible for the coordination with related work specified elsewhere and to provide all hardware, accessories and appurtenances required for a complete installation, including all fabrication and mounting hardware.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05500 – Metal Fabrications
- B. Section 07900 – Joint Fillers, Sealants, and Caulking

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. ASTM D2996 – Specification for Filament Wound Reinforced Thermosetting Resin Pipe
 - 2. ASTM D3647 - Standard Practice for Classifying Reinforced Plastic Pultruded Shapes According to Composition
 - 3. ASTM D3917 - Standard Specification for Dimensional Tolerances of Thermosetting Glass - Reinforced Plastic Pultruded Shapes
 - 4. ASTM D4385 - Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products

1.4 SUBMITTALS

- A. The Contractor shall submit shop drawings showing fabrication details and a Performance Affidavit for all items specified herein in accordance with Section 01300 - Submittals.
- B. Certification of compliance with ASTM Standards.
- C. Where specifically requested, design calculations sealed by a currently Registered Professional Engineer in the State of Michigan.

1.5 QUALITY ASSURANCE

- A. All fiberglass items of the same type provided shall be the products of a single manufacturer for compatibility.

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- B. It shall be the Contractor's responsibility to ensure that the fiberglass items and appurtenances furnished shall be compatible and have the necessary operating clearances with the structural elements and equipment shown on the Drawings.
- C. Manufacturer shall provide a 3-year warranty on all FRP products against defect in material and workmanship.

PART 2 – MATERIALS

2.1 GENERAL

- A. The manufacturer shall maintain a continuous quality control program and shall, upon request, furnish the Engineer with certified test reports consisting of physical tests of samples.
- B. Ultraviolet light resistive resins shall be used for all exterior locations and where specified.
- C. All FRP resins shall be flame resistant and shall meet the requirements of ASTM D 635 and ASTM E 84, Class 1 with a maximum flame spread rating of 25.
- D. All edges shall be sealed in the mold where possible. Machined or cut edges shall be sealed with a compatible resin system.

2.2 FIBERGLASS WEIRS AND BAFFLES

- A. Fiberglass reinforced polyester (FRP) weirs and baffles shall be installed where shown on the Drawings. All weir plates, scum baffle plates, buff plates, and cover plates shall be FRP. A "low profile" resin system shall be used to insure that all surfaces are smooth, resin rich, free of voids and porosity, without dry spots, crazes, or unreinforced areas to provide increased corrosion and weather resistance. All edges shall be sealed in the mold. Resin shall be of the isophthalic type. Plate thickness shall be 3/8 inch minimum, or as shown on the Drawings. FRP weirs and baffles shall be blue green in color. Each section shall be of the depth and overall length as indicated on the Drawings. Each section shall be provided with mounting holes at 12 inches on center, unless shown otherwise on the Drawings, to provide a minimum 2 inch vertical or horizontal adjustment. Sections shall be secured to walls or trough with 316 stainless steel anchor bolts and 5-inch minimum diameter washers to prevent short circuiting. Ends of weir plates shall be secured with 6-inch-wide butt plates arranged to allow for horizontal expansion. Type 316 stainless steel anchor bolts shall be furnished by the FRP supplier.
- B. Laminate shall contain a glass content of 30+2% using Type "E" glass with chrome or silane finish. Powdered reinforcements shall consist of 47.5+1% of resin mixture. Final laminate thickness shall be within +10 percent of the nominal specified thickness. Ultraviolet absorbers shall be added to the resin to prevent deterioration from sunlight. Where weir plates are of nonstandard length or nonstandard mounting hole configuration, such machined or cut edges shall be resin sealed with seal mix.
- C. All items shall be manufactured in accordance with ASTM D2996 and ASTM D3917. The manufacturer shall maintain a continuous quality control program and shall, upon request,

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furnish the Engineer with certified test reports consisting of physical tests of samples to verify that the laminate has the following minimum physical properties:

<u>Requirement</u>	<u>Minimum Results</u>	<u>Test Method</u>
Tensile Strength (psi)	14,000	ASTM D 638
Flexural Strength (psi)	25,000	ASTM D 790
Flexural Modulus (psi)	1.0 x 10 ⁶	ASTM D 790
Impact, Notched, Izod, (foot pound per inch)	15.0	ASTM D 256
Barcol Hardness	Minimum, 35 Average, 40	ASTM D2583
Water Absorption, (% 24 hours)	0.1 Max	ASTM D 570
Average coefficient of thermal expansion (inch per inch per °F)	10.5 x 10 ⁻⁶	ASTM D 696

- D. The procedure used in determining the above properties shall be in accordance with the ASTM Standards, Part 35, using the method designated above. Hardness tests shall be made on the resin rich surfaces of the test samples. Test coupons shall be prepared in accordance with the appropriate ASTM test method.
- E. Baffle plate lengths shall be made to fit the installation but lengths shall not exceed 10 feet. Lap plates shall be provided to secure the ends of the plates. Type 316 stainless steel hardware shall be furnished by the FRP supplier for securing baffle plates to 316 SS support brackets and lap plates. Type 316 SS anchor bolts shall be used for anchoring scum baffle supports to the wall.
- F. All items furnished under this Section shall be as manufactured by PLASTI FAB, Inc., Warminster Fiberglass, Leopold, or equal.

2.3 EFFLUENT TROUGHS

- A. Effluent troughs shall be furnished and installed as shown on the Drawings. Troughs shall be manufactured by Fiberglass Fabricators, Inc., or Leopold Company, Division of Sybron Corporation, or Plasti Fab, Inc., or equal.
- B. Effluent troughs shall be constructed of fiberglass reinforced polyester (FRP) and shall be the length indicated with approximately 18 inches inside width and 21 inches depth as shown on the Drawings. Each trough shall have a minimum wall thickness of 1/4 inch and shall be reinforced with triangular shaped longitudinal stiffener sections molded as an integral part of the trough. Maximum vertical deflection under maximum loading conditions (150 lbs./lin. ft. upward and downward) shall not exceed 3/16 inches at mid span between supports. Sidewall

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horizontal alignment shall be + 1/8 inch over the entire trough length. Trough joints shall be designed for + 1/8-inch thermal expansion or contraction without stressing the structure. Each trough shall consist of a maximum of four (4) sections and shall be connected with a watertight seal. Trough color shall be blue green translucent and include an ultraviolet light blocking agent added to the resin. An integrally molded water stop shall be provided on the discharge end of each trough. The closed end of the trough shall be integrally molded during trough construction to a minimum of 3/8 inch thickness and arranged for bolting to the basin. Trough intermediate supports shall be 316 stainless steel and connected to the overhead concrete support beams. Each intermediate and rear support shall provide means of vertical adjustment. All support hardware and angles shall be 316 stainless steel and shall be provided by trough manufacturer. The manufacturer shall submit details of supports with calculations showing vertical and horizontal deflection, support calculations and physical properties of the FRP.

- C. Effluent troughs shall be provided with adjustable weir plates, minimum 2-inch adjustment, which are completely independent of any trough stiffening members. Weir plates are described above.
- D. The inner surface of the trough shall be reinforced with glass surfacing mat. This shall be followed with 3 ounces or more of chopped strand glass laminate in a minimum of two (2) layers. Final laminate thickness shall be within a tolerance of plus 1/16 inch or minus "O" of minimum laminate thickness. Void content of the complete laminate shall not exceed 2 1/2 percent of laminate volume.
- E. The manufacturer shall certify that troughs and the testing of the trough materials is in complete compliance with the latest ASTM Standards. Copies of the certified test reports on the troughs shall be submitted to the Engineers in addition to the required calculations and physical properties stated in these Specifications.
- F. Guide frames shall be surface mounted with 316 stainless steel anchor bolts, or shall be embedded in concrete as shown on the Drawings. All stop plates shall be sealed with neoprene rubber to form a watertight seal.

2.4 CONNECTIONS

- A. All connections shall be non-corrosive, non-staining, and concealed where practicable, as detailed on the Drawings or specified herein.
- B. Fiberglass fasteners shall be "Fibrebolt", as manufactured by Strongwell, Inc., or equal.
- C. All metal fasteners shall be Type 316 stainless steel, except for sodium hypochlorite applications, Hastelloy C-276 or fiberglass fasteners where manufacturer recommends shall be used unless noted otherwise.
- D. Holes for bolts and screws shall be drilled.
- E. Joints exposed to weather shall be formed to exclude water.
- F. Design and installation of fiberglass items shall provide for expansion and contraction, prevent shearing of bolts, screws and other fastenings, and provide close fitting of sections.

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PART 3 -- EXECUTION

3.1 FABRICATION

- A. All cut edges and holes shall be sealed with a compatible resin.
- B. All FRP items shall conform to the dimensions indicated on the Drawings.
- C. All fiberglass items described in this Section shall be supplied by a manufacturer that normally fabricates such items so that appearance and quality control are first class.

3.2 HANDLING, TRANSPORTING, AND STORING

- A. All FRP items shall be properly packed, labeled and stored in accordance with Divisions 1 and 11, and where directed by the Engineer.

3.3 INSTALLATION

- A. Installation of all items shall be according to manufacturer's instructions, unless otherwise noted.
- B. Exposed threads of FRP bolts shall be sealed with a compatible resin after installation of the bolts. Where bolts are attaching removable items, the exposed threads shall be sealed with a light coat of polyurethane sprayed onto the threads.
- C. Weirs and baffles shall be installed in full accordance with the manufacturer's recommendations. Joints between weir plates and concrete and butting weir plates shall be watertight. The Contractor shall seal all weirs with caulk approved by the Engineer after weirs are set, checked for level, and are within specified tolerances.

END OF SECTION

SECTION 07531

SINGLE PLY ROOFING - FULLY ADHERED - CONVENTIONAL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Membrane roofing, base flashings roofing membrane and counter flashings.
- B. Pre-fabricated pipe supports for placement on roofing membrane, to support utilities serving roof-top equipment.
- C. Rigid insulation.

1.2 RELATED SECTIONS

- A. Section 01300 – Submittals.
- B. Section 06114 - Wood Blocking and Curbing: Wood nailers.
- C. Section 07620 - Sheet Metal Flashing and Trim: Miscellaneous metal flashing fabrications.

1.3 REFERENCES

- A. ASTM C1289 – Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
- B. ASTM D412 - Rubber Properties in Tension.
- C. ASTM D471 - Standard Test Method for Rubber Property - Effect of Liquids.
- D. ASTM D624 - Rubber Property - Tear Resistance.
- E. ASTM E96 - Water Vapor Transmission of Materials.
- F. FM 4470 (Factory Mutual Engineering Corporation) - Roof Assembly Classifications.
- G. NRCA (National Roofing Contractors Association) - Roofing and Waterproofing Manual.
- H. UL 790 - Fire Hazard Classifications.

1.4 SYSTEM DESCRIPTION

- A. Elastomeric Sheet Membrane Conventional Roofing System: One ply membrane system with insulation.
- B. Provide tapered insulation for saddles/crickets as necessary to direct flow for positive drainage around roof penetrations.

1.5 SUBMITTALS FOR REVIEW

- A. Product Data: Provide characteristics on membrane materials, flashing materials, insulation, and adhesive.
- B. Shop Drawings: Indicate setting plan for insulation, joint and termination detail conditions and conditions of interface with other materials.
- C. Samples: Submit two 6 x 6 inch in size illustrating insulation.

1.6 SUBMITTALS FOR INFORMATION

- A. Section 01300 - Submittals: Procedures for submittals.
- B. Manufacturer's Installation Instructions: Indicate special precautions required for seaming the membrane.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer's Field Reports: Submit under provisions of Section 01400.
- E. Reports: Indicate procedures followed; ambient temperatures, humidity, wind velocity during application.

1.7 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with ten (10) years experience.
- B. Installer:
 - 1. Company specializing in performing the work of this section with ten (10) years experience and approved by system manufacturer.
 - 2. Installer must be certified in the last 3 years by the system manufacturer to install their provided system per these specifications in accordance with the following:
 - a. Firestone: Master Contractor
 - b. Carlisle: Perfection Council or Award or ESP Award
 - c. Johns Mansville: Summit Club Member (or higher)
 - d. **Provide documentation regarding certification as part of bid submittal.**
- C. Perform Work in accordance with NRCA Roofing and Waterproofing Manual and manufacturer's instructions.

1.8 REGULATORY REQUIREMENTS

- A. Conform to applicable Michigan Building Code for roof assembly fire hazard requirements.
- B. UL 790: Class A Fire Hazard Classification.
- C. FM 4470: Roof Assembly Classification, of Class 1 Construction, wind uplift requirement of 1-90, in accordance with FM Construction Bulletin 1-28.

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1.9 PRE-INSTALLATION MEETING

- A. Section 01039 - Coordination and Meetings: Pre-installation meeting.
- B. Convene one week before starting work of this section.

1.10 DELIVERY, STORAGE, AND PROTECTION

- A. Section 01600 - Material and Equipment: Transport, handle, store, and protect products.
- B. Store products in weather protected environment, clear of ground and moisture.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Section 01600 - Material and Equipment: Environmental conditions affecting products on site.
- B. Do not apply roofing membrane during inclement weather and ambient temperatures below 32 degrees F or above 95 degrees F.
- C. Do not apply roofing membrane to damp or frozen deck surface.
- D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed during same day.

1.12 COORDINATION

- A. Coordinate work under provisions of Section 01039.
- B. Coordinate the work with the installation of associated metal flashings, as the work of this section proceeds.

1.13 WARRANTY

- A. Manufacturer - Provide 20-Year, Non-Prorated – Total System Roofing Warranty covering roof membrane, flashings and insulation/cover board for all new installations. Roofing Manufacturer representative shall sign off and approve the roofing installation prior to warranty period commencing.
- B. Contractor – Upon completion, Contractor shall also provide a 2-Year Workmanship Warranty to cover all leaks due to defective workmanship or materials. Warranty shall include metal flashing installation; warranty shall list location of flashings and total lengths of installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS - MEMBRANE MATERIAL

- A. Firestone – RubberGard EPDM Membrane (60 mil)
- B. Johns Manville – 60NR

- C. Carlisle - SureSeal (60 mil)
- D. Substitutions – none permitted.

2.2 MEMBRANE AND ASSOCIATED MATERIALS

- A. Membrane: EPDM non-reinforced, 0.060 inch thick, utilizing maximum roll width to reduce number of seams; color - black.
- B. Seaming Materials: As recommended by membrane manufacturer.

2.3 ATTACHMENT MATERIALS

- A. Surface Conditioner: As recommended by membrane manufacturer, compatible with membrane.
- B. Membrane Adhesives: As recommended by membrane manufacturer.
- C. Insulation Adhesive for Concrete Deck: As recommended by membrane manufacturer.
- D. Thinner and Cleaner: As recommended by adhesive manufacturer, compatible with sheet membrane.
- E. See “Accessories” for fasteners, termination bars and reglets.

2.4 INSULATION MATERIALS

- A. Manufacturers – roofing membrane manufacturer shall approve all insulation and fastening components used with their roofing system.
- B. Thermal resistance ratings specified are based on ASTM C1289 (2011) and are presented as a Long Term Thermal Resistance (LTTR) value, reflecting a product’s 15 year weighted average of the foam’s thermal resistance. Submittals shall indicate R-Value in LTTR format.
- C. All insulation shall be approved by the roofing manufacturer for use with their roofing system, to obtain and maintain the warranty specified. Insulation shall be applied in minimum two layers (including the cover board), unless approved otherwise by roofing manufacturer:
 - 1. Type 1 (High Density Cover Board): High Density rigid cover board shall be used over rigid insulation. Material to be approved for warranty requirements specified.
 - 2. Type 2 (Thermal Insulation): Polyisocyanurate foam core bonded to universal fiber glass reinforced facer sheets.
 - 3. Type 3 (Tapered Thermal Insulation): Similar to Type 2, polyisocyanurate foam core bonded to universal fiber glass reinforced facer sheets, tapered board.
- D. Type 1: ASTM C1289, Type II, Class IV, Grade 2, high density polyisocyanurate rigid cover board; with the following characteristics:
 - 1. Board Density: Minimum 100 PSI.
 - 2. Board Size: 48 x 48 inch or 48 x 96 inch.
 - 3. Board Thickness: 1/4 inch to 1/2 inch (as required for roofing system to be provided.)
 - 4. Board Edges: Square.

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- E. Type 2: ASTM C1289, Type II, Class I, Grade 2 polyisocyanurate board insulation with the following characteristics:
 - 1. Board Density: Minimum 20 PSI.
 - 2. Board Size: 48 x 48 or 48 x 96 inch
 - 3. Board Thickness per Layer: 1 inch minimum.
 - 4. Thermal Value LTTR: Minimum R-Value of 5.7 for 1 inch board.
 - 5. Board Edges: Square.

- F. Type 3: ASTM C1289, Type II, Class I, Grade 2 tapered, polyisocyanurate board insulation with the following characteristics:
 - 1. Board Density: Minimum 20 PSI.
 - 2. Board Size: 48 x 48 inch
 - 3. Slope – 1/4 inch per foot as shown on the Drawings.
 - 4. Board Thickness: 1/2 inch to 4 inch in a single layer.
 - 5. Thermal Value LTTR: Minimum R-Value of 5.7 based on a typical tapered board thickness of 1 inch or greater.
 - 6. Board Edges: Square.

2.5 FLASHINGS

- A. Flexible Flashings: Same material as membrane EPDM; black color, as recommended by the manufacturer.

2.6 ACCESSORIES

- A. Sealants: As recommended by membrane manufacturer to maintain warranty specified.
- B. Stack Boots: Flexible boot and collar for pipe stacks through membrane.
- C. Termination Bars: Stainless steel or aluminum with beveled edges to receive sealant cap after installation. Fasteners shall be non-corrosive, fastened at 12 inches O.C. max. Cut termination bars at inside and outside corners, do not bend around corners.
- D. Reglet Terminations - Metal counter flashings shall be as specified in Section 07620.
- E. Vapor Barrier – Provide Mfr. recommended vapor barrier over deck.
 - 1. Prepare surfaces and prime per Mfr. recommendations.
 - 2. At metal deck surfaces, install 5/8" DensDeck prior to installation of vapor barrier. Use stainless steel fasteners at all locations receiving DensDeck.
 - 3. All penetrations through vapor barrier are to be sealed.
- F. Roof Walk Pads: Minimum 30 inch x 30 inch, black cured polymer walkway pad with raised, non-slip profile, compatible with approved EPDM roofing membrane. Space pads with maximum 3 inch gap between pad edges to promote drainage.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Cover all equipment, tanks, vehicles, etc. at the interior of the building to protect from damage or falling debris during installation. Determine any conflicts with conduit, piping, lights, etc. mounted to the underside of the deck to ensure that these components are not damaged during installation.
- B. Verify that surfaces and site conditions are ready to receive work.
- C. Verify deck is supported and secure.
- D. Verify deck is clean and smooth, free of depressions, waves, or projections.
- E. Verify deck surfaces are dry and free of snow or ice.
- F. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set.

3.2 PREPARATION

- A. Concrete Deck - Fill surface honeycomb and variations with latex filler in concrete deck, as required by roofing manufacturer to establish suitable, acceptable insulation base surface. Infill roof openings where equipment is to be removed, as may be called for on the Drawings.

3.3 VAPOR RETARDER APPLICATION

- A. Apply vapor retarder to precast concrete deck surface with adhesive in accordance with manufacturer's instructions.
- B. Extend vapor retarder up and over parapet walls and curbing.
- C. Lap flexible flashing over vapor barrier of wall construction to provide continuity of vapor barrier seal.

3.4 INSULATION APPLICATION

- A. Concrete Roof Deck
 - 1. Apply adhesive to concrete deck in accordance with adhesive and insulation manufacturer's instructions. Embed insulation into adhesive with full contact.
 - 2. If multiple layers of insulation are used over the concrete deck, apply adhesive to the top surface of insulation. Embed the second layer of insulation into adhesive, with joints staggered minimum 6 inch from joints of first layer.
 - 3. Adhesive used shall be selected and installed in accordance with the manufacturer's requirements based on the insulation used and an FM I-90 uplift requirement.
 - 4. Insulation glued to the concrete deck.
 - 1. Outdoor temperatures must be 35 degrees and rising for adhesive installation.
 - 2. Store adhesive in 60 degree to 80 degree temperature until ready to use.
 - 3. Adhesive shall be 60 degrees to 80 degrees when installed.
 - 4. Adhesive shall be installed in accordance with the manufacturer's requirements based on the insulation used and an I-90 uplift requirement.

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5. Verify proper mixing prior to applying adhesive to deck, no marbling in the adhesive is allowed.
6. Do not allow bead of adhesive to "skin over" before installing insulation board.
7. Pull test shall be required each day to verify applicability for that day.
8. Insulation boards shall be weighted down after placement until adhesive is set to insure full continuous contact.

F. All Insulation Installation:

1. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
2. Where tapered boards are provided for general roof surface slope, utilize a minimum slope of 1/8 inch per foot from the high side to the low side for positive drainage. Use 1/2 inch per foot on all cants, saddles, crickets.
3. Apply no more insulation than can be covered with membrane in same day.

3.5 MEMBRANE INSTALLATION

- A. Apply membrane in accordance with manufacturer's instructions.
- B. Place membrane in final position and fold back per manufacturer's instructions. Place membrane so that the seams shed water. Remove dusting agent and dirt from backside of membrane.
- C. Apply adhesive at a rate as recommended by the Manufacturer.
- D. Test adhesive for Readiness (Touch-Push Test).
- E. Roll out membrane, free from air pockets, wrinkles, or tears. Firmly press sheet into place without stretching.
- F. Overlap edges and ends and seal in accordance with the manufacturer's requirements.
- G. Shingle joints on sloped substrate in direction of drainage.
- H. Extend membrane up a minimum of 8 inches onto vertical surfaces.
- I. Seal membrane around roof penetrations.

3.6 FLASHINGS AND ACCESSORIES

- A. Fabricate custom roofing expansion joints to replace existing joints as specified and shown on the Drawings.
- B. Seal flashings and flanges of items penetrating membrane.
- C. Equipment drains, gas lines and pipe penetrations; conduits, vents etc. shall be supported and flashed per the roofing manufacturer's warranty requirements, as a part of this Work.

- D. Pipe Supports – On roof pipe supports shall be DuraBlok or equal, non-penetrating base supports.
- E. Include extra thickness of roofing material under pipe supports. Pieces shall be fully adhered to membrane underneath.

3.7 FIELD QUALITY CONTROL

- A. Section 01400 - Quality Control: Field inspection and testing.
- B. Manufacturer shall inspect the completed roof for proper installation and the Engineer shall be notified a minimum of 48 hours in advance of the date of the inspection.
- C. Correct identified defects or irregularities.

3.8 CLEANING

- A. In areas where finished surfaces are soiled by Work of this section, consult manufacturer of surfaces for cleaning advice and conform to their documented instructions.
- B. Repair or replace defaced or disfigured finishes caused by work of this section.

3.9 PROTECTION OF FINISHED WORK

- A. Protect building surfaces against damage from roofing work.
- B. Where traffic must continue over finished roof membrane, protect surfaces.
- C. Protect installation from damage until acceptance by Owner.

END OF SECTION

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SECTION 07620

SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Sill flashings, drip edges and formed metal trim pieces not specified elsewhere.
- B. Metal edge and preformed roof flashings.
- C. Counterflashings over base flashings.
- D. Metal Parapet Caps.

1.2 RELATED SECTIONS

- A. Section 07900 - Joint Sealers.
- B. Section 09900 - Painting: Back coating of dissimilar materials.

1.3 REFERENCES

- A. AISI (American Iron and Steel Institute) - Stainless Steel -Uses in Architecture.
- B. ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate.
- C. ASTM B32 - Solder Metal.
- D. ASTM B209 - Aluminum and Alloy Sheet and Plate.
- E. ASTM B370 - Copper Sheet and Strip for Building Construction.
- F. ASTM D4586 - Asphalt Roof Cement, Asbestos-Free.
- G. CDA (Copper Development Association) - Contemporary Copper, A Handbook of Sheet Copper Fundamentals, Design, Details and Specifications.
- H. FS O-F-506 - Flux, Soldering, Paste and Liquid.
- I. NRCA (National Roofing Contractors Association) - Roofing Manual.
- J. SMACNA - Architectural Sheet Metal Manual.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

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- C. Submit two samples 6 x 6 inch in size illustrating metal finish color for each type for flashing to be provided.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with AISI, CDA, NRCA and SMACNA standard details and requirements. Several SMACNA standard documents and fabrications are referred to, in this Work. Maintain one copy of each document/ cut sheet on site. Where not specifically detailed or specified, comply with SMACNA's "Architectural Sheet Metal Manual". Conform to dimensions and profiles recommended unless more stringent requirements are indicated.
- B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

- A. Fabricator and Installer: Company specializing in sheet metal flashing work with 3 years documented experience.

1.7 PRE-INSTALLATION CONFERENCE

- A. Convene one week prior to commencing work of this section, under provisions of Section 01039.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 01600.
- B. Stack preformed and prefinished material to prevent twisting, bending, or abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- C. Prevent contact with materials which may cause discoloration or staining.

1.9 COORDINATION

- A. Coordinate work under provisions of Section 01039.
- B. Coordinate with the work of Section 07531 for installing flashing in conjunction with roofing materials.

PART 2 PRODUCTS

- 2.1 MANUFACTURERS – fabrications shall be factory fabricated to the extent possible. Contractor may elect to provide field fabricated copings and flashings as long as the metals are as specified and fabricated as called for in this Section. Manufacturer shall note flashing configurations as required on the Drawings. Provide product configurations by one of the following:

- A. IMETCO, Inc.
- B. PAC-CLAD Peterson

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C. W.P. Hickman

2.2 SHEET MATERIALS

- A. Aluminum Sheet: ASTM B209, shop pre-coated as specified under “2.5 Finish”; color shall be as selected by Owner and match existing Headworks Building. Minimum aluminum sheet material gages shall be as follows:
1. 0.032 inch thick for miscellaneous sheet metal not specified elsewhere.
 2. 0.040 inch thick for formed metal parapet caps.

2.3 ACCESSORIES

- A. Fasteners: Same material and finish as flashing metal (unless noted otherwise on the Drawings), with soft neoprene washers.
- B. Protective Backing Paint: Specified in Section 09900.
- C. Sealant: Specified in Section 07900.
- D. Bedding Compound: Type appropriate for substrate.
- E. Plastic Cement: ASTM D4586, asbestos free.

2.4 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Fabricate cleats of same material as sheet, interlockable with sheet.
- C. Form pieces in longest possible lengths; profiles as shown on the Drawings.
- D. Hem exposed edges on underside 1/4 (6 mm) inch; miter and seam corners.
- E. Fabricate corners from one piece with minimum 6 inch long legs; miter joint shall be watertight – welded or standing seal construction; sealing with only sealant is not acceptable.
- F. Fabricate vertical faces with bottom edge formed outward 1/4 inch (6 mm) and hemmed to form drip.
- G. Field fabricated copings and expansion joints shall have standing seams and continuous cleat securement in accordance with SMACNA recommendations. Lap seams and butt joints in field fabricated copings and flashings are not acceptable.

2.5 FINISH

- A. Polyvinylidene Fluoride Finish: Factory-applied baked-on polyvinylidene fluoride resin finish containing not less than 70% Kynar 500 or Hylar 5000 resin, with minimum total dry film thickness of 1.0 mil (0.2 mil primer and 0.8 mil finish), in color as selected per approved samples.
- B. Back paint concealed metal surfaces as specified for dissimilar metal protection on aluminum flashings and fabrications.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify roof openings, pipes, sleeves, ducts, or vents through roof are solidly set.
- B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.2 PREPARATION

- A. Install starter and edge strips, and cleats before starting installation.

3.3 INSTALLATION

- A. Conform to drawing details for steep roofing included in the NRCA manual.
- B. Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted.
- C. Apply plastic cement compound between metal flashings and felt flashings.
- D. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- E. Seal metal joints watertight.
- F. Solder metal joints for full metal surface contact. After soldering, wash metal clean with neutralizing solution and rinse with water.

3.4 FIELD QUALITY CONTROL

- A. Field inspection will be performed under provisions of Section 01400.
- B. Inspection will involve Engineer observation of work during installation to ascertain compliance with specified requirements.

END OF SECTION

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SECTION 07900

JOINT SEALERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. The Contractor shall furnish all materials, equipment and perform all work to complete installation of all exterior caulking at the new Odor Control Building, and all caulking repairs and modifications to the existing Headworks Building (per plans), including, but not necessarily limited to, the following:
 - 1. Joints between exterior metal frames and adjacent materials.
 - 2. Exterior joints at doors, sash, and other openings to provide air and weathertight construction.
 - 3. Interior joints at door frames, sash and adjacent construction and other locations, as shown on the Drawings.
- B. Preparing substrate surfaces.
- C. Sealant and joint backing.

1.2 RELATED SECTIONS

- A. Section 03300 - Concrete Work: Sealants required in conjunction with cast-in-place concrete.
- B. Section 04300 - Unit Masonry: Sealants required in conjunction with masonry.

1.3 REFERENCES

- A. ASTM C804 - Use of Solvent-Release Type Sealants.
- B. ASTM C920 - Elastomeric Joint Sealants.
- C. ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.
- D. SWRI (Sealant, Waterproofing and Restoration Institute) -Sealant and Caulking Guide Specification.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations and color availability.
- C. Manufacturer's Installation Instructions: Indicate special procedures, surface preparation, and perimeter conditions requiring special attention.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience.
- B. Applicator: Company specializing in performing the work of this section with minimum three years.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.8 COORDINATION

- A. Coordinate work under provisions of Section 01039.
- B. Coordinate the work with all sections referencing this section.

1.9 WARRANTY

- A. Provide five year warranty under provisions of Section 01700.
- B. Warranty: Include coverage for installed sealants and accessories which fail to achieve weathertight seal, and exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.1 SEALANTS

- A. Polyurethane Sealant: ASTM C920, Grade NS, Type M, Class 25, two component, chemical curing, non-staining, non-bleeding, capable of constant water immersion, non-sagging type; color to match adjacent surfaces; MasterSeal NP-2 manufactured by BASF; Dynatrol II, manufactured by Pecora Corporation, Bostik Chem-Calk 505 or Dymeric 240 FC by Tremco.
 - 1. Elongation Capability: Minimum 25 percent.
 - 2. Service Temperature Range: -40 to 180 degrees F (-40 to 82 degrees C)
 - 3. Shore A Hardness (After aging): 22
- B. Polyurethane Sealant, Self-Leveling: ASTM C920, Grade P, Type M, Class 25, Use T, two component, chemical curing, non-staining, non-bleeding, capable of water immersion; color to match adjacent surfaces; MasterSeal SL-2 Paving Joint Sealant, manufactured by BASF; Pecora Urexpam NR-200, manufactured by Pecora Corporation.
 - 1. Elongation Capability: Minimum 25 percent.
 - 2. Service Temperature Range: -40 to 150 degrees F (-40 to 65 degrees C)

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3. Shore A Hardness: 30

- C. Polyurethane sealants shall be used as the standard sealant on this project for general application throughout the work unless a particular sealant is indicated on the Drawings for a specific location.

2.2 ACCESSORIES

- A. Primer: Non-staining type, as may be recommended by sealant manufacturer to suit application.
- B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.
- C. Joint Backing: Round, closed cell polyethylene foam rod; sized to compress 25% when inserted in the joint; "Kool-Rod" by W.R. Meadows or equal.
- D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that substrate surfaces and joint openings are ready to receive work.
- B. Verify that joint backing and release tapes are compatible with sealant.

3.2 PREPARATION

- A. Remove loose materials and foreign matter which might impair adhesion of sealant.
- B. Clean and prime, if recommended, joints in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with ASTM C804 for solvent release sealants.

3.3 INSTALLATION

- A. Install sealant in accordance with manufacturer's instructions.
- B. Measure joint dimensions and size materials to achieve required 2:1 width/depth ratios.
- C. Install joint backing to achieve a joint depth dimension no greater than 1/3 of the joint width.
- D. Install bond breaker where joint backing is not used.
- E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
- F. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

G. Tool joints concave.

3.4 CLEANING

A. Clean work under provisions of 01700.

B. Clean adjacent soiled surfaces.

3.5 PROTECTION OF FINISHED WORK

A. Protect finished installation under provisions of Section 01500.

B. Protect sealants until cured.

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SECTION 08225

FRP FLUSH PANEL DOORS AND FRAMES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Flush fiber reinforced polyester doors.
- B. Flush fiber reinforced polyester panels.
- C. Fiber reinforced door frames.

1.2 RELATED SECTIONS

- A. Section 07900 – Joint Sealers.
- B. Section 08710 – Door Hardware.
- C. Section 09900 – Field Painting.

1.3 REFERENCES

- A. Aluminum Association, Inc. (AA).
 - 1. AA 6061-T6 – Heavy Duty Structures.
 - 2. AA 6063-T5 – Extrusions, Pipe, Architectural.
 - 3. AA DAF-45 – Designation System for Aluminum Finishes.
- B. American Architectural Manufacturers Association (AAMA).
 - 1. AAMA 2605-98 – Superior Performing Organic Coatings (Kynar).
 - 2. AAMA 609 – Anodized Architectural Finishes Cleaning and Maintenance.
 - 3. AAMA 610.02 – Painted Architectural Products Cleaning and Maintenance.
 - 4. AAMA 611-98 – Anodized Architectural Standards.
 - 5. AAMA 701 – Pile Weather-strip.
 - 6. AAMA 1304 – Voluntary Specification for Forced Entry Resistance of Side-Hinged Door Systems.
 - 7. AAMA 1503-98 – Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
- C. American Society for Testing Materials (ASTM).
 - 1. B 209 – Aluminum and Aluminum-Alloy Sheet and Plate.
 - 2. B 221 – Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - 3. C 591-01 – Unfaced Preformed Rigid Cellular Polyisocyanurate.
 - 4. D 256-97 – Izod Pendulum Impact Resistance of Plastics.
 - 5. D 570-98 – Water Absorption of Plastics.
 - 6. D 1242-95a – Resistance of Plastic Materials to Abrasion.
 - 7. D 1621 – Compressive Properties of Rigid Cellular Plastics.
 - 8. D 1622 – Apparent Density of Rigid Cellular Plastics.

9. D 1623 – Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.
10. D 2126 – Response of Rigid Cellular Plastics to Thermal and Humid Aging.
11. D 2583-95 – Indentation Hardness of Rigid Plastics (Barcol Impressor).
12. D 3841-97 – Glass-Fiber-Reinforced Polyester Plastic Panels.
13. E 84 – Surface Burning Characteristics.
14. E 330-02 – Structural Performance of Exterior Doors.
15. E 331-00 – Water Resistance.
16. E 283-91 – Air infiltration.

D. Florida Building Code; Dade County Building Codes

1. TAS-201-95.1 – Impact Test Procedures (Inclusive of Large Missile Impact).
2. TAS-202-95.1 – Criteria for Testing Impact and Non-Impact Resistant Building Envelope Components Using Uniform Static Air Pressure.
3. TAS-203-95.1 – Criteria for Testing Products Subject to Cyclic Wind Pressure Loading.

E. International Building Code Compliant:

Section 2603.4.1.7 – Doors not required to have a fire protection rating. Foam core has a Class “A” rating covered with 0.032 aluminum skins. Outer FRP skin also carries a Class “A” Rating for flame spread and smoke development.

1.4 TESTING AND PERFORMANCE REQUIREMENTS

- A. Meets or exceeds ICC Building Code Standards.
- B. FRP Panels shall be USDA accepted.
- C. Manufacturer to supply test data certification upon request.

1.5 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Manufacturer’s descriptive literature for each type door and frame; include the following information:
 1. Fabrication methods.
 2. Finishing.
 3. Hardware preparation.
 4. Accessories.
 5. Schedule of doors and frames indicating the specific reference numbers used on the owner’s project documents, noting door type, frame type, size, handing and applicable hardware.
 6. Details of core and edge construction. including factory construction specifications.
 7. Certification of manufacturer’s qualifications.
- C. Shop Drawings: Indicate the following:
 1. Elevations and details of each door and frame type.
 2. Schedule of doors and frames.
 3. Location and installation requirements for hardware.
 4. Thickness of materials, joints.

5. Connections and trim.
 6. A drawing depicting front and rear door elevations showing hardware with bill of material for each door.
 7. Drawing showing dimensional location of each hardware item and size of each door.
 8. Individual part drawing and specifications for each hardware item and FRP part or product.
 9. Construction and mounting detail for each frame type.
- D. Samples: Two sets of color chips representing specified colors and finishes shall be furnished upon request.
- E. Verification Samples:
1. Submit samples of each type consisting of FRP door corner construction, minimum 6-inch by 6-inch (150 mm) shall be furnished upon request.
 2. When color or texture variations are anticipated, include two or more units in each set of samples indicating extreme limits of variations.
- F. Hardware Templates: Provide finish hardware mounting details.
- G. Manufacturer's Installation Instructions: Printed installation instructions for each product, including product storage requirements.
- H. Operations and Maintenance Data: Printed instructions for each product.

1.6 QUALITY ASSURANCE

- A. Referenced Standards
1. Door Properties
 - a. Standard test method for steady state thermal transmission properties by means of the heat flow meter apparatus.
 - b. Successfully completed 1,000,000 cycles test in accordance with:
 - 1) AAMA 920-03 – Specification for Operating Cycle Performance of Side-Hinged Exterior Door Systems.
 - 2) ANSI A250.4-2001 – Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frame Anchors and Hardware Reinforcings.
 - 3) NWWDA TM-7 Test Method to Determine the Physical Endurance of Wood Doors and Associated Hardware Under Accelerated Operating Conditions.
 2. Laminate Properties
 - a. Door face plate is a minimum of 0.125 inch thick fiberglass reinforced plastic molded into one continuous sheet starting with a 25 mil resin-rich gelcoat layer resin integrally molded with multiple layers of 1.5 oz. sq ft fiberglass mat and one layer of 18 oz per square yard fiberglass woven roving saturated with special resin. Door plate weight shall not be less than 0.97 lbs per square foot at a ratio of 30/70 glass resin.
 - b. Laminated plate by itself evaluated in accordance with Florida Building Code TAS 201 Large Missile Impact Test as per ASTM-1996-05b, Standard Specification for Performance of Exterior Windows, Curtain Wall, Doors and Storm Shutters Impacted by Windborne Debris in Hurricanes. The missile (a

2 x 4 with a weight of 9 lbs shot from a cannon at a velocity of 50 ft/sec) did not penetrate the door face plate.

- 1) ASTM D 638 Tensile Strength Properties of Plastic
- 2) ASTM D 790 Flexural Strength Properties of Plastic
- 3) ASTM D 2583 Indention Hardness of Plastics
- 4) ASTM D 256 Izod Pendulum Impact Resistance
- 5) ASTM D 792 Density/Specific Gravity Of Plastics
- 6) ASTM D 1761 Mechanical Properties of Fasteners
- 7) ASTM E 84 Surface Burning Characteristics of Materials
- 8) ASTM G 155 Xenon Light Exposure of Non Metallic Materials
- 9) ASTM D 635 Method For Rate of Burning
- 10) ASTM D 2843 Smoke Density
- 11) ASTM D 1929 Self Ignition Temperature Properties
- 12) SFBC PA 201 Impact Procedures for Large Missile Impact

3. Core Properties

- a. ASTM C 177 Thermal Properties of Materials
- b. ASTM D 1622 Density and Specific Gravity
- c. ASTM E 84 Surface Burning Characteristics of Materials
- d. WDMA TM-10 and TM-5 Firestop ASTM E 152 U.L 10(b)
- e. ASTM E90-04- Sound Transmission Loss
- f. ASTM E413-04- Classification for Rating Sound Insulation
- g. ASTM E1332-90- Standard Classification for Determination of Outdoor-Indoor Transmission Class
- h. ASTM E2235-04- Standard Test for Determination of Decay Rates for Use in Sound Insulation Methods

4. Door Assembly:

- a. ASTM C 518 Standard test method for steady state thermal transmission properties by means of the heat flow meter apparatus.
- b. Wind-load test certification conforming to TAS 202-95.1 and ASTM E 330 on samples of previous products shall be provided for the type of door to be used.

B. Qualifications

1. Manufacturer Qualifications: A company specialized in the manufacture of fiberglass reinforced plastic (FRP) doors and frames as specified herein with a minimum of 25 years of documented experience and with a record of successful in-service performance for the applications as required for this project.
2. Installer Qualifications: An experienced installer who has completed fiberglass door and frame installations similar in material, design, and extent to those indicated and whose work has resulted in construction with a record of successful in-service performance.
3. Surface Limitations: Obtain doors and frames through one source fabricated from a single manufacturer.
4. Source Limitations:
 - a. Hardware and accessories for all FRP doors as specified in Section 08710 should be provided and installed by the fiberglass door and frame manufacturer.
 - b. Glass for windows in doors shall be furnished and installed by door and frame manufacturer in accordance with related section, Division 8, Glazing.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Delivery of doors and frames to be palletized or individually crated. Doors shall be side protected with surrounding grooved 2-inch (50.8 mm) by 4-inch (101.6 mm) wood frame and covered with 275-pound (124.74 kg) test corrugated cardboard.
- B. Unload and store with minimum handling. Inspect delivered doors and frames for damage. Minor damaged items may be repaired. If items cannot be repaired to equal in all respects to new work; remove damaged items and replace with new.

Store products of this section under cover in manufacturer's unopened packaging until installation.

- 1. Place units on minimum 4-inch (100.6 mm) wood blocking.
- 2. Avoid non-vented plastic or canvas covers.
- 3. Remove packaging immediately if packaging becomes wet.
- 4. Provide ¼-inch (6.35 mm) air spaces between stacked doors.

1.8 PROJECT CONDITIONS

- A. Field Measurements: Take field measurements of areas to receive aluminum frames; note discrepancies on submitted shop drawings.

1.9 SCHEDULING

- A. Ensure that all approvals and/or shop drawings are supplied or returned to the manufacturer in time for fabrication without affecting construction progress schedule.
- B. Ensure that templates and/or actual hardware requested by manufacturer are available in time for fabrication without affecting construction progress schedule.

1.10 WARRANTY

- A. Manufacturer:
 - 1. Warrant doors, frames, and factory installed hardware against failure in materials and workmanship, including excessive deflection, faulty operation, defects in hardware installation, and deterioration of finish or construction in excess of normal weathering.
 - 2. Standard Period.
 - a. Ten years starting on date of shipment.
 - 3. Limited lifetime
 - a. Covers failure of corner joinery, core deterioration, and delamination or bubbling of door skin and corrosion of all-fiberglass products while the door is in its specified application in its original installation.
- B. Installer: Warrant installation procedures and performance for five years against defects due to workmanship and materials handling.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Chem-Pruf Door Co., Ltd., P.O. Box 4560 Brownsville, Texas 78523 Phone: 1-800-444-6924-7943, Fax: 956-544-7943, Website: www.chem-pruf.com .
- B. Alternate Mfr.: Corrim Company, 1870 Stillman Dr., Oshkosh, WI 54901-1010, Phone: (920) 231-2000, Fax: (920) 231-2238. Website: www.corrim.com
- C. Substitutions shall be subject to the provisions of Section 01300.

2.2 FRP DOORS

- A. Doors shall be made of fiberglass reinforced plastic (FRP) using Class 1 premium resin with no fillers that is specifically tailored to resist chemicals and contaminants typically found in environment for which these specifications are written. Doors shall be 1 ¾ inch thick and of flush construction, having no seams or cracks. For consistency in the resin chemistry tailored for this application and to maintain the same physical properties throughout the structure, all fiberglass components including face plates, stiles and rails and frames must be fabricated by the same manufacturer. Components obtained through various outside sources for plant assembly will not be accepted.
- B. Door Plates shall be 0.125 inch thick minimum, molded in one continuous piece, starting with 25 mil gelcoat of the color specified, integrally molded with multiple layers of 1.5 ounces per square foot fiberglass mat and one layer of 18 ounce per square yard fiberglass woven roving. Each layer shall be individually laminated with resin as mentioned above. Door plate weight shall not be less than 0.97 lbs per square foot at a ratio of 30/70 glass to resin. Plate alone to withstand Large Missile Impact per FBC TAS 201. Face plates manufactured using the pultrusion process does not allow for a smooth molded gelcoat finish, the use of woven roving for adequate plate thickness, strength and weight, or the appropriate glass to resin ratio and will not meet the quality standards of this project.
- C. Stiles and Rails shall be constructed starting from the outside toward the inside, with a matrix of at least three layers of 1.5 ounce per square foot of fiberglass mat. The stile and rail shall be molded in one continuous piece to a U-shaped configuration and to the exact dimensions of the door. In this manner there will be no miter joints and disparate materials used to form the one-piece stile and rail.
- D. Core material shall be Polypropylene plastic honeycomb core with a non woven polyester veil for unparalleled plate bonding, 180 PSI typical compression range unless otherwise requested.
- E. Internal Reinforcement shall be #2 SPF of sufficient amount to adequately support required hardware and function of same.
 - 1. **IMPORTANT:** In addition to Mfr. standard reinforcing, provide continuous solid hinge reinforcement at entire length of door at jamb side.
- F. Finish of door frame shall be identical with 25 mil resin-rich gelcoat of the specified color integrally molded in at time of manufacture resulting in a smooth gloss surface that is dense and non-porous. To achieve optimum surface characteristics, the gelcoat shall be cured within

a temperature range of 120F to 170F creating an impermeable outer surface, uniform color throughout, and a permanent homogeneous bond with the resin/fiberglass substrate beneath. Only the highest quality gelcoat will be used to ensure enduring color and physical properties. Paint and/or post application of gelcoat results in poor mechanical fusion and will be deemed unacceptable for this application. The finish of the door and frame must be field repairable without compromising the integrity of the original uniform composite structure, function, or physical strength.

- G. Window openings shall be provided for at time of manufacture and shall be completely sealed so that the interior of the door is not exposed to the environment. Fiberglass retainers, which hold the glazing in place, shall be resin transfer molded with a profile that drains away from glazing. The window retainer must match the color and finish of the door plates with 25 mil of resin-rich gelcoat integrally molded in at time of manufacture. Mechanical fasteners shall not be used to attach retainers. Glass, as specified herein, shall be furnished and installed by door and frame manufacturer. In order to maintain uniform appearance, product longevity and the corrosion resistance this application requires, window retainers fabricated from Metal, PVC or Vinyl will not be accepted.
- H. Louver openings shall be completely sealed so that the interior of the door is not exposed to the environment. Louvers are to be solid fiberglass "V" Vanes and shall match the color and finish of the door plates.
- I. Transoms shall be identical to the doors in finish, construction, materials, thickness and reinforcement.
- J. Intersecting Edges – Provide rabbet edges at intersecting edges of top and bottom leafs at stacked door/panel locations.

2.3 FRP FRAMES

- A. Frames (rated and non-rated) shall be fiberglass and manufactured using the resin transfer method creating one solid piece (no voids) with complete uniformity in color and size. Beginning with a minimum 25 mil gelcoat layer molded in and a minimum of two layers of continuous strand fiberglass mat saturated with resin, the frame will be of one-piece construction with molded stop. All frame profiles shall have a core material of 2 psf polyurethane foam.
- B. Finish of frame shall be identical to the door with 25 mil resin-rich gelcoat of the specified color integrally molded in at time of manufacture. To achieve optimum surface characteristics, the gelcoat shall be cured within a temperature range of 120F to 170F creating an impermeable outer surface, uniform color throughout, and a permanent homogeneous bond with the resin/fiberglass substrate beneath. Only the highest quality gelcoat will be used to ensure enduring color and physical properties. Paint and/or post application of gelcoat result in poor mechanical fusion and will be deemed unacceptable for this application. The finish of the door and frame must be field repairable without compromising the integrity of the original uniform composite structure, function or physical strength.
- C. Jamb/Header connection shall be mitered for tight fit.

- D. Internal Reinforcement shall be continuous within the structure to allow for mounting of specified hardware. Reinforcing material shall be a dense matrix of cloth glass fibers and premium resin with a minimum hinge screw holding value of 1000 lbs per screw. All reinforcing materials shall be completely encapsulated. Documented strength of frame screw holding value after third insert must be submitted. Dissimilar materials, such as steel or wood, will be deemed unacceptable as reinforcement for hardware attachment.
 - 1. **IMPORTANT:** In addition to Mfr. standard reinforcing, provide continuous solid hinge reinforcement at entire length of frame at jamb side.
- E. Mortises for hardware shall be accurately machined by CNC to hold dimensions to +/- 0.010 inch in all three axis.
- F. Hinge pockets shall be accurately machined by CNC to facilitate heavy duty hinges at all hinge locations, using shims when standard weight hinges are used.

2.4 HARDWARE

- A. See Section 08710.
- B. The special nature of this material requires that all related hardware as specified must be furnished and installed by the door frame manufacturer to maintain product quality and function as well as to ensure sufficient support/reinforcement, precision tooling and proper sealing methods are provided.

PART 3 EXECUTION

3.1 INSTALLATION CONDITIONS

- A. Verification of Conditions
 - 1. Verify openings are correctly prepared to receive doors and frames.
 - 2. Verify openings are correct size and depth in accordance with submittal drawings.
- B. Installer's Examination
 - 1. Door installer shall examine conditions under which construction activities of this section are to be performed and submit a written report to general contractor if conditions are unacceptable.
 - 2. General Contractor shall submit two copies of the installer's report to the architect within 24 hours of receipt.
 - 3. Installer shall not proceed with installation until all unacceptable conditions have been corrected.

3.2 INSTALLATION

- A. All single doors to be shipped completely assembled in the frame with hardware installed. Double doors to be pre-hung at the factory to ensure a proper fit and that hardware functions properly, then disassembled for shipping purposes.
- B. Install doors and frames in accordance with manufacturer's instructions and approved shop drawings; set frames plumb, square, level, and aligned to receive doors.

- C. Anchor frames to adjacent construction in strict accordance with recommendations and approved shop drawings and within tolerances specified in manufacturer's instructions.
 - 1. Seal metal-to-metal joints between framing members using good quality elastomeric sealant.
- D. Hang doors with required clearances as follows:
 - 1. Hinge and Lock Stiles: 0.125-inch (3.17 mm).
 - 2. Between Meeting Stiles: 0.250-inch (6.34 mm).
 - 3. At Top Rails: 0.125-inch (3.17 mm).
 - 4. Between Door Bottom and Threshold: 0.125-inch (3.17 mm).
- E. Field alteration of doors or frames to accommodate field conditions is strictly prohibited.
- F. Adjust doors and hardware to operate properly.
- G. Install glazing in glazing frames.
- H. Installation of door hardware is specified in Section 08710.

3.3 CLEANING

- A. Upon completion of installation, thoroughly clean door and frame surfaces.
- B. Do not use abrasive, caustic or acid cleaning agents.

3.4 PROTECTION

- A. Protect products of this section from damage caused by subsequent construction.
- B. Repair damaged or defective products to original specified condition in accordance with manufacturer's recommendations.
- C. Replace damaged or defective products, which cannot be repaired to Architect's acceptance.

END OF SECTION

SECTION 08331

OVERHEAD COILING DOORS

PART 1 GENERAL

1.1 SUMMARY

- A. Insulated overhead coiling door, motorized operator and controls.
 - 1. Controls for the door shall be coordinated with the Electrical requirements of these Specifications.
 - 2. Note the Building interior is classified as Class I, Division 1, Group D environment.
 - 3. Coiling Door: Surface mounted at Exterior of Building, operator & controls.

1.2 Related Sections:

- A. Section 05500-Metal Fabrications: Support framing.
- B. Division 16000 – Conduit, wire and methods as they pertain to the electric circuit to door operator and from door operator to control station.

1.3 REFERENCES

- A. ASTM International:
 - 1. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 2. ASTM A666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 - 3. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - 4. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.4 SYSTEM DESCRIPTION

- A. Electric Operation: Electric motor operated unit with manual chain operation override in case of power failure.

1.5 DESIGN REQUIREMENTS

- A. Wind Loads: Design door assembly to withstand wind/suction load of 20 psf (958 Pa), with maximum deflection of 1/120, and without damage to [door] [shutter] or assembly components.
- B. Operation: Design door assembly including operator, to operate for not less than 20,000 cycles and 10 cycles per day.
- C. Unit shall be designed with Explosion Proof features compatible with NEMA Class 1 Group D construction.

1.6 SUBMITTALS

- A. Section 01300 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details.
- C. Product Data: Submit general construction, component connections and details, wiring diagram and electrical equipment.
- D. Manufacturer's Installation Instructions: Indicate installation sequence and procedures, and adjustment and alignment procedures.

1.7 CLOSEOUT SUBMITTALS

- A. Section 01700 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit lubrication requirements and frequency, and periodic adjustments required.

PART 2 PRODUCTS

2.1 OVERHEAD COILING DOORS

- A. Manufacturers:
 - 1. Overhead Door Corp, Model 625 (Basis of Design).
 - 2. Raynor Garage Doors, Model DuraCoil Optima.
 - 3. Wayne Dalton, Model 800C.
 - 4. Substitutions: Section 01600 - Product Requirements.

2.2 COMPONENTS

- A. Overhead Coiling Stormtite Insulated Service Doors: Overhead Door Corporation Model 625.
 - 1. Curtain: Interlocking roll-formed slats as specified following. Endlocks shall be attached to each end of alternate slats to prevent lateral movement. Windlocks shall be attached to a minimum of every 6th slat.
 - a. Flat profile type F-265i for doors up to 40 feet (12.19 m) wide.
 - b. Front slat fabricated of:
 - 1) Aluminum .040 inch (1 mm).
 - c. Back slat fabricated of:
 - 1) Aluminum .024 inch (.06 mm).
 - d. Slat cavity filled with CFC-free foamed-in-place, polyurethane insulation.
 - 1) R-Value: 7.7, U-Value: 0.13.
 - 2) Sound Rating: STC-21.
 - 2. Performance:
 - a. Through Curtain Sound Rating: Sound Rating: STC-28 (STC-30+ with HZ noise generator) as per ASTM E 90.
 - b. Installed System Sound Rating: STC-21 as per ASTM E 90.
 - c. U-factor: 0.91 NFRC test report, maximum U-factor of no higher than 1.00.

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- d. Air Infiltration: Meets ASHRAE 90.1 & IECC 2012/2015 C402.4.3 Air leakage <1.00 cfm/ft².
 - 3. Slats and Hood Finish:
 - a. Aluminum: Slats and hood shall be aluminum finished as follows.
 - 1) Finish: Powder Coat:
 - a) PowderGuard Premium powder coat color as selected by the Architect.
 - 4. Weatherseals:
 - a. Vinyl bottom seal, exterior guide and internal hood seals.
 - b. Interior guide weatherseal.
 - 5. Bottom Bar:
 - a. Extruded aluminum angle minimum thickness 1/8 inch (3 mm) bolted back to back to reinforce curtain in the guides.
 - 6. Guides: Three structural steel angles.
 - 7. Brackets:
 - a. Galvanized steel to support counterbalance, curtain and hood.
 - 8. Finish; Bottom Bar, Guides, Headplate and Brackets:
 - a. Finish: PowderGuard Zinc base coat, gray with PowderGuard Premium powder coat color as selected by the Architect.
 - 9. Counterbalance: Helical torsion spring type housed in a steel tube or pipe barrel, supporting the curtain with deflection limited to 0.03 inch per foot of span. Counterbalance is adjustable by means of an adjusting tension wheel.
 - 10. Hood: Provide with internal hood baffle weatherseal.
 - a. Aluminum hood with intermediate supports as required.
 - 11. Electric Motor Operation: Provide UL listed electric operator, size as recommended by manufacturer to move door in either direction at not less than 2/3 foot nor more than 1 foot per second.
 - a. Sensing Edge Protection:
 - 1) Electric sensing edge.
 - b. Operator Controls:
 - 1) Push-button operated control stations with open, close, and stop buttons.
 - 2) Controls for both interior and exterior location.
 - 3) Controls surface mounted.
 - c. Special Operation:
 - d. Motor Voltage: 115/230 single phase, 60 Hz.
 - 12. Windload Design:
 - a. Standard windload shall be 20 PSF.
 - 13. Locking:
 - a. Chain keeper locks for chain hoist operation.
 - 14. Wall Mounting Condition:
 - a. Face-of-wall mounting.
- B. Mechanical Disconnect Device:
- 1. Provide hand-operated disconnect or mechanism for automatically engaging sprocket-chain operator and releasing brake for emergency manual operation while disconnecting motor, without affecting timing of limit switch.
 - 2. Provide electric door operator assembly with electric motor and factory-pre-wired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-

control stations, control devices, integral gearing for locking door, and accessories, as specified below and as required for proper operation.

- C. Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency auxiliary operator.
- D. Hardware: Door shall be fitted with a roller chain and sprocket operator for emergency operation.
- E. Weatherstripping (Exterior Assemblies): Moisture and rot proof, resilient type for complete weathertight installation.
- F. Safety Edge: Manufacturer's standard safety edge, intrinsically safe and weather seal located at door bottom, full width, sensitized type, wired to reverse upon striking object.

2.3 ELECTRIC OPERATOR:

- 1. Description: UL 325 2010 compliant, side mounted, totally enclosed, nonventilated.
 - 2. Model: Overhead Door RHX or equal
 - 3. Motor Enclosure: NEMA Class 1 Group D Explosion Proof enclosure.
 - 4. Motor Rating: minimum 3/4 hp; continuous duty.
 - 5. Motor Voltage: 230/460 volt, three phase, 60 Hz.
 - 6. Motor Controller: NEMA ICS 2, full voltage, reversing magnetic motor starter.
 - 7. Controller Enclosure: NEMA 7
 - 8. Brake: Adjustable friction clutch type, activated by motor controller.
- B. Control Station: Standard three button Open-Stop-Close momentary control for operator; 24 volt circuit; surface mounted, NEMA 4 intrinsically safe.
 - C. Motor, wiring and all controls shall meet NEMA Class 1 Group D Explosion Proof construction requirements.
 - D. Provide adjustable limit switches, interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions with NEMA 4 or NEMA 7, Class I, Division 1, group D enclosures as applicable.
 - E. All wiring associated with the door shall be run in rigid galvanized conduit.
 - 1. This shall include all wiring from the control panel to the motor and remote devices.
 - 2. Refer to Electrical Specifications for conduit requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01300 - Administrative Requirements: Coordination and project conditions.
- B. Verify opening sizes, tolerances and conditions are acceptable.

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3.2 INSTALLATION

- A. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.
- B. Securely and rigidly brace components suspended from structure.
- C. Fit and align assembly including hardware; level and plumb, to provide smooth operation.
- D. Install fire rated door assemblies in accordance with NFPA 80 and requirements for fire listing.
- E. Coordinate installation of electrical service with Division 16. Complete wiring from disconnect to unit components and from fire alarm system to door operator.
- F. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 07900.
- G. Install perimeter trim and closures.

3.3 ERECTION TOLERANCES

- A. Section 01400 - Quality Requirements: Tolerances.
- B. Maintain dimensional tolerances and alignment with adjacent Work.
- C. Maximum Variation From Plumb: 1/16 inch.
- D. Maximum Variation From Level: 1/16 inch.
- E. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft straight edge.

3.4 ADJUSTING

- A. Section 01700 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Adjust door, hardware and operating assemblies for smooth and noiseless operation.
- C. Test smoke activated assemblies for proper activation.

3.5 CLEANING

- A. Section 01700 - Execution and Closeout Requirements: Final cleaning.
- B. Clean door and components.
- C. Remove labels and visible markings.

END OF SECTION

SECTION 08520

ALUMINUM WINDOWS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes Heavy-Commercial Grade aluminum windows of the performance class indicated. Window types required include the following:
 - 1. Fixed Windows.
- B. Related Section: Section 08800 "Glazing".

1.3 DEFINITIONS

- A. Performance class number, included as part of the window designation system, is the actual design pressure in pounds force per square foot (pascals) used to determine structural test pressure and water test pressure.
 - 1. Structural test pressure, wind load test, is equivalent to 150 percent of the design pressure.
 - 2. Water-leakage-resistance test pressure is equivalent to 15 percent of the design pressure with 2.86 lbf/sq. ft. (137 Pa) as a minimum for Residential, Commercial, and Heavy-Commercial Grade windows.
 - 3. Water-leakage-resistance test pressure is equivalent to 20 percent of the design pressure with 8 lbf/sq. ft. (383 Pa) as a minimum for Architectural Grade windows.

1.4 PERFORMANCE REQUIREMENTS

- A. General: Provide aluminum windows engineered, fabricated, and installed to withstand normal thermal movement, wind loading, and impact loading without failure, as demonstrated by testing manufacturer's standard window assemblies representing types, grades, classes, and sizes required for Project according to test methods indicated.
- B. Compliant with current edition of ASHRAE 90.1 for Building Envelope Requirements.
- C. Test Criteria: Testing shall be performed by a qualified independent testing agency based on the following criteria:
 - 1. Design wind velocity at Project site is 80 mi./h (129 km/h).
 - 2. Heights of window units above grade at window centerline are indicated on or can be determined from the Drawings. Consult with the Architect, if necessary, to confirm required loading and test pressures.

3. Test Procedures: Test window units according to ASTM E 283 for air infiltration, both ASTM E 331 and ASTM E 547 for water penetration, and ASTM E 330 for structural performance.
- D. Performance Requirements: Testing shall demonstrate compliance with requirements indicated in AAMA 101 for air infiltration, water penetration, and structural performance for type, grade, and performance class of window units required. Where required design pressure exceeds the minimum for the specified window grade, comply with requirements of AAMA 101, Section 3, "Optional Performance Classes," for higher than minimum performance class.
1. Air-Infiltration Rate for Fixed Windows: Not more than 0.06 cfm/ft. of area for an inward test pressure of 6.24 lbf/sq. ft. (299 Pa).
 2. Water Penetration: No water penetration as defined in the test method at an inward test pressure of 15 percent of the design pressure.
 3. Structural Performance: No failure or permanent deflection in excess of 0.4 percent of any member's span after removing the imposed load, for a positive (inward) and negative (outward) test pressure of 30 lbf/sq. ft. (1437 Pa).
 4. Condensation Resistance: Where window units are indicated to be "thermally improved," provide units tested for thermal performance according to AAMA 1503.1 showing a condensation resistance factor (CRF) of 45.
 5. Thermal Movements: Provide window units that allow thermal movement resulting from the following maximum change (range) in ambient temperature when engineering, fabricating, and installing aluminum windows to prevent buckling, opening of joints, and overstressing of components, connections, and other detrimental effects. Base engineering calculation on actual surface temperatures of materials due to solar heat gain and nighttime sky heat loss.
 - a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.5 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each type of window required, including the following:
 1. Construction details and fabrication methods.
 2. Profiles and dimensions of individual components.
 3. Data on hardware, accessories, and finishes.
 4. Recommendations for maintaining and cleaning exterior surfaces.
- C. Shop Drawings showing fabrication and installation of each type of window required including information not fully detailed in manufacturer's standard Product Data and the following:
 1. Layout and installation details, including anchors.
 2. Elevations at 1/4 inch = 1 foot (1:50) scale and typical window unit elevations at 3/4 inch = 1 foot (1:20) scale.
 3. Full-size section details of typical composite members, including reinforcement and stiffeners.
 4. Location of weep holes.
 5. Panning details.

6. Hardware, including operators.
7. Window cleaning provisions.
8. Glazing details.
9. Accessories.

- D. Samples for initial color selection on 12-inch- (300-mm-) long sections of window members. Where finishes involve normal color variations, include Sample sets showing the full range of variations expected.
- E. Samples for Verification: The Architect reserves the right to require additional samples that show fabrication techniques, workmanship, and design of hardware and accessories.
- F. Test reports from a qualified independent testing agency indicating that each type, grade, and size of window unit complies with performance requirements indicated based on comprehensive testing of current window units within the last 5 years. Test results based on use of down-sized test units will not be accepted.

1.6 QUALITY ASSURANCE

- A. **Installer Qualifications:** Engage an experienced Installer who has completed installation of aluminum windows similar in material, design, and extent to those required for this Project and with a record of successful in-service performance.
- B. **Single-Source Responsibility:** Obtain aluminum windows from one source and by a single manufacturer.
- C. **Product Options:** The Drawings indicate sizes, profiles, dimensional requirements, and aesthetic effects of aluminum windows and are based on the specific window types and models indicated. Other aluminum window manufacturers whose products have equal performance characteristics may be considered provided deviations in size, profile, and dimensions are minor and do not alter the aesthetic effect. Refer to Division 1 Section "Substitutions."

1.7 PROJECT CONDITIONS

- A. **Field Measurements:** Check window openings by field measurements before fabrication and show recorded measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.8 WARRANTY

- A. **General Warranty:** The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. **Special Warranty:** Submit a written warranty signed by aluminum window manufacturer agreeing to repair or replace window components that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, water leakage, air infiltration, or condensation.
 2. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- C. Warranty Period for Metal Finishes: 10 years after date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Fixed, Awning and Casement Windows, 1-3/4" X 4-1/2" profile, thermally broken:
 - a. Tubelite
 - b. Kawneer
 - c. Capitol Aluminum & Glass Corp.
 - d. DeSCo Architectural Inc.
 - e. Graham Architectural Products Corporation.
 2. Substitutions - Under the provisions of Section 01600.

2.2 MATERIALS

- A. Aluminum Extrusions: Provide alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish, but not less than 22,000-psi (150-MPa) ultimate tensile strength and not less than 0.085 inch thick at any location for main frame and sash members.
- B. Fasteners: Provide aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by manufacturer to be noncorrosive and compatible with aluminum window members, trim, hardware, anchors, and other components of window units.
1. Exposed Fasteners: Except where unavoidable for application of hardware, do not use exposed fasteners. For application of hardware, use fasteners that match finish of member or hardware being fastened, as appropriate.
- C. Anchors, Clips, and Window Accessories: Fabricate anchors, clips, and window accessories of aluminum, nonmagnetic stainless steel, or hot-dip zinc-coated steel or iron complying with requirements of ASTM B 633; provide sufficient strength to withstand design pressure indicated.
- D. Compression-Type Glazing Strips and Weatherstripping: Unless otherwise indicated, and at manufacturer's option, provide compressible stripping for glazing and weatherstripping such as molded EPDM or neoprene gaskets complying with ASTM D 2000 Designation 2BC415 to 3BC620, or molded PVC gaskets complying with ASTM D 2287, or molded expanded EPDM or neoprene gaskets complying with ASTM C 509, Grade 4.
1. Provide stripping with integral centerline barrier fin of semirigid plastic sheet of polypropylene.

- E. Sealant: For sealants required within fabricated window units, provide type recommended by manufacturer for joint size and movement. Sealant shall remain permanently elastic, nonshrinking, and nonmigrating. Comply with Division 7 Section "Joint Sealants" of these Specifications for selection and installation of sealants.

2.3 ACCESSORIES

- A. General: Provide manufacturer's standard accessories that comply with indicated standards.

2.4 GLASS AND GLAZING MATERIALS

- A. Glass and Glazing Materials: As specified in Section 08800.
- B. Glazing Materials: Type to suit application to achieve weather, moisture, and air infiltration requirements.

2.5 FIXED SASH

- A. Window Grade and Class: Comply with requirements of AAMA Grade and Performance Class CW.

2.6 FABRICATION

- A. General: Fabricate aluminum window units to comply with indicated standards. Include a complete system for assembly of components and anchorage of window units.
 - 1. Provide units that are reglazable without dismantling sash or ventilator framing.
 - 2. Prepare window sash or ventilators for glazing, except where preglazing at the factory is indicated.
- B. Thermally Improved Construction: Fabricate window units with an integral, concealed, low-conductance, thermal barrier, located between exterior materials and window members exposed on interior, in a manner that eliminates direct metal-to-metal contact.
 - 1. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.
 - 2. Subframes: Provide subframes with anchors for window units as shown, of profile and dimensions indicated but not less than 0.062-inch- (1.6-mm-) thick extruded aluminum. Miter or cope corners, and weld and dress smooth with concealed mechanical joint fasteners. Finish to match window units.
 - 3. Mullions: Provide mullions and cover plates as shown, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections, as indicated.
 - 4. Glazing Stops: Provide screw-applied or snap-on glazing stops, coordinated with glass selection and glazing system indicated. Finish to match window units.

2.7 FINISHES

- A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to applying and designating finishes.

- B. Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes.
- C. Class I, Anodic Finish: AAMA 611. Architectural Class I, integrally colored or electrolytically deposited color coating complying with AAMA 606.1, 607.1 or AAMA 608.1.
 - 1. Color: Clear Anodized.

PART 3 EXECUTION

3.1 INSPECTION

- A. Inspect openings before installation. Verify that rough or masonry opening is correct and sill plate is level.
 - 1. Masonry surfaces shall be visibly dry and free of excess mortar, sand, and other construction debris.
 - 2. Metal surfaces shall be dry; clean; free of grease, oil, dirt, rust and corrosion, and welding slag; without sharp edges or offsets at joints.

3.2 INSTALLATION

- A. Comply with manufacturer's specifications and recommendations for installing window units and other components of the Work.
- B. Set window units plumb, level, and true to line, without warp or rack of frames or sash. Provide proper support and anchor securely in place.
 - 1. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials by complying with requirements specified under "Dissimilar Materials" Paragraph in appendix to AAMA 101.
- C. Set sill members and other members in a bed of sealant or with joint fillers or gaskets, as shown on Shop Drawings, to provide weathertight construction. Refer to Division 7 Section "Joint Sealants" for compounds, fillers, and gaskets to be installed concurrently with window units. Coordinate installation with wall flashings and other components of the Work.
 - 1. Sealants, joint fillers, and gaskets to be installed after installation of window units are specified in another Division 7 Section.

3.3 ADJUSTING

- A. Adjust operating sash and hardware to provide a tight fit at contact points and at weatherstripping for smooth operation and a weathertight closure.

3.4 CLEANING

- A. Clean aluminum surfaces promptly after installing windows. Exercise care to avoid damage to protective coatings and finishes. Remove excess glazing and sealant compounds, dirt, and other substances. Lubricate hardware and other moving parts.

3.5 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to aluminum window manufacturer, that ensure window units are without damage or deterioration at the time of Substantial Completion.

END OF SECTION

SECTION 08710

DOOR HARDWARE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Hardware for doors.
- B. Thresholds.
- C. Weatherstripping, seals and door gaskets.

1.2 RELATED SECTIONS

- A. Section 01700 - Contract Closeout: Turning keys over to the Owner; tagging keys.
- B. Section 08225 – FRP Flush Panel Doors and Frames

1.3 REFERENCES

- A. ANSI A117.1 - Specifications for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People.
- B. NFPA 80 - Fire Doors and Windows.
- C. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures.
- D. NFPA 252 - Fire Tests of Door Assemblies.
- E. UL 10B - Fire Tests of Door Assemblies.
- F. UL 305 - Panic Hardware.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Shop Drawings: Indicate locations and mounting heights of each type of hardware, and material types.
- C. Submit manufacturer's parts lists, and templates to steel door and frame manufacturers for mortising of steel doors and frames. All necessary templates and schedules shall be provided at such time so not to delay the Work. Refer to Delivery, Storage and Handling herein for forwarding requirements of hardware.
- D. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention.

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1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01700.
- B. Record actual locations of installed cylinders and their master key code.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01700.
- B. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.

1.7 QUALITY ASSURANCE

- A. Perform work in accordance with the following requirements:
 - 1. ANSI A117.1 - Specifications for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People.
 - 2. NFPA 101.
 - 3. NFPA 80.
 - 4. NFPA 252.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.
- B. Hardware Supplier: Company specializing in supplying industrial quality door hardware, approved by manufacturer to install their products.
- C. Hardware Supplier Personnel: Employ an Architectural Hardware Consultant (AHC) to assist in the work of this section.

1.9 REGULATORY REQUIREMENTS

- A. Conform to applicable code for requirements for fire rated doors and frames.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 01600.
- B. Upon request, the Contractor shall submit physical hardware as required, direct to door manufacturer's plant for installation. Such shipments shall be forwarded, prepaid.
- C. Package hardware items individually; label and identify each package with door opening code to match hardware schedule.
- D. Provide construction cores and cylinders; upon completion of the Work, install new cores and cylinders as necessary for Owner approval.
- E. Deliver keys for final cylinders to Owner by security shipment direct from hardware supplier.

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1.11 COORDINATION

- A. Coordinate the work with other directly affected sections involving manufacture or fabrication of internal reinforcement for door hardware.

1.12 WARRANTY

- A. Provide five-year warranty under provisions of Section 01700.
- B. Warranty: Include coverage for door closers.

1.13 MAINTENANCE MATERIALS

- A. Provide maintenance materials under provisions of 01700.
- B. Provide special wrenches and tools applicable to each different or special hardware component.
- C. Provide maintenance tools and accessories supplied by hardware component manufacturer.

PART 2 PRODUCTS

2.1 HARDWARE FOR METAL DOORS

- A. Description of Hardware Components:
 - 1. The following description of designated hardware components is limited to elements that are established as constants throughout the project and are not intended to be complete.
 - 2. When a description is coupled with criteria established under the heading "Hardware Sets," the hardware for a particular opening will be complete to the extent necessary for a satisfactory installation and operation of the door.
 - 3. The descriptions contain "Key Words" which when used in the hardware sets in conjunction with other notations, will establish the hardware elements assigned to the individual door.
- B. Hinges:
 - 1. Doors over 4' wide: Stainless steel with ball bearings (steel hinges on fire rated doors), flat button tip, Stanley FBB 199 32D, Hager BB 1199, Ives A5111 or McKinney No. T4B3386.
 - a. Hinges shall be 4-1/2" x 4-1/2" minimum 0.180 inches thick stainless steel with stainless steel pins.
 - b. Use 2 pair of hinges per leaf.
 - c. Provide non-removable pins at all hinges.
 - 2. Doors up to 4' wide: Stainless steel barrel type continuous hinge – Stanley 650HD, or approved equal
- C. Mortise Lockset:
 - 1. Corbin/Ruswin ML2000 series, Schlage L9000 series or Best 40H series hardware, for severe climatic conditions or marine use with all stainless steel and bronze

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construction to resist corrosion, including non-ferrous or stainless steel case. Match cylinder type and keying to Owner's current standard.

2. Inside lever always free for egress.
3. Minimum 3/4 inch latch bolt throw designed to accept 1-5/32 inch diameter standard cam cylinder and adjustable from flat front to standard bevel either hand.
4. Provide all exterior doors with lock protector plates.
5. Levers shall be cast stainless steel; escutcheons shall be wrought stainless steel.
6. Each lockset set shall be furnished complete with one pair of levers and escutcheons.
7. Lever and Escutcheon model shall be Schlage "L06". Similar style for Corbin/Russwin or Best.

D. Standard Lockset:

1. Corbin/Russwin CL3500 series, Schlage ND series, or Best 9K series, Grade 1 Cylindrical type, lever style lockset. Match cylinder type and keying to Owner's current standard.
2. Inside lever always free for egress.
3. Lever and Escutcheon Model shall be Schlage "Rhodes". Similar style for Corbin/Russwin or Best.
4. Manufacturer of Standard locksets shall be the same as Mortise locksets used.

E. Exit Devices:

1. US-26D smooth case with stainless steel touch bar and lever trim, mortised cylinder recess:
2. Base unit for rated and non-rated doors:
 - a. Von Duprin, No. 9875L x 996L break away lever design or
 - b. Precision Apex Series 2300 x V4908A
3. Provide matching Von Duprin 9827 Series or Apex 2200 Series, UL labeled device for fire rated double doors (provide vertical rod and bottom latch guards for this unit).
4. Interior doors do not require cylinders, unless noted in the hardware sets below.
5. Provide blank escutcheons for these locations; trim shall always be operable.
6. Strikes shall be stainless steel, dustproof; coordinate with exit devices, as required.
7. Provide tamperproof security type screws for installation.
8. Hardware for mechanical and electrical rooms shall have knurled levers.

F. Push/Pull Plates:

1. Brushed stainless steel, Rockwood Model No. 107 x 70B x 70 (8 inch x 3/4 inch pull) beveled four sides.
2. Plates shall have cylinder cut out.
3. Plate/pull unit on pull side of door; push plate on push side of door. (Turn knob not required.)

G. Closers:

1. Surface mounted closer with cast iron cylinder, adjustable back check, and spring power with key valve adjusting screws for closing and latching speeds and back check control.
2. Closer arms shall allow for minimum 100 degree swing.
3. Closers shall be LCN 4000 Series, Ryobi D4550 or Engineer approved equal, resistant to severe climatic conditions with a U.S.-26D sprayed finish on covers.
4. Provide SRI finish on closer bodies and arms.

5. All required accessories, brackets, plates, arms, spacers, etc, required for a complete installation shall be provided whether specifically called for or not.
 6. All closers on exterior doors shall be mounted on the interior side of the door.
- H. Kickplates:
1. Dull stainless steel (US32D), (.050) ga. 10" high except at doors with narrow bottom stiles where the height shall be reduced to 1/2" less than the height of the rail and shall be 1-1/2" LDW on push side of single doors, 1" LDW on push side of pairs of doors.
 2. Mount kickplates flush with lock style edge of pairs of doors.
 3. Provide kickplates at the push side of doors.
- I. Thresholds:
1. Thermally broken, Barrier Free Accessible, 5-inch wide, full width of door frame, Zero Model No. 625A, National Guard Products Model No. 8425, or Reese Model No. S282D; finish shall be aluminum mill finish.
 2. Provide one threshold for each exterior door opening.
- J. Weatherstripping:
1. Durable Products, National Guard Products, Reese, Zero or Pemko.
 2. Model No. listed are National Guard Products (NGP).
 3. Head and jambs, NGP No. 160VA.
 4. Door bottom brush seal, NGP D608A.
 5. Finish for weatherstripping shall be natural satin clear anodized aluminum.
 6. Provide weatherstrip for all exterior doors.
 7. Backpaint all surfaces in contact with dissimilar metals for protection prior to installation.
- K. Astragal for Double Door:
1. Durable Products, National Guard Products, Reese Zero or Pemko.
 2. Model No. listed is National Guard Products (NGP). NGP No. 178SA (silicone gasket) face fastened to active leaf.
 3. Finish for astragal shall be natural satin clear anodized aluminum. Provide astragal at all exterior, double door meeting stiles.
- L. Flush Bolts:
1. Manual type, Rockwood 555 x US26D, one each top and bottom, spring loaded, forged brass construction with dust proof strike #570 at bottom.
- M. Overhead Holder:
1. Glynn Johnson No. 904H x US32D or Rockwood 19014 x US32D.
- N. Chain Bolt:
1. Stanley 1055 Chain Bolt, or approved equal.
- O. Surface Bolt:
1. Trimco 3922 Heavy Duty Surface Bolt, or approved equal.
- P. Door Stops: Wall –

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1. Ives WS406CVX convex wall bumper with 630 stainless steel finish. All doors that contact the adjacent wall surface or obstacle when they are in the open position, shall receive a door stop.

Q. Lock Protectors

1. All single exterior pedestrian doors shall be provided with lock protectors similar to Ives LG series in stainless steel.
2. Coordinate exact model with door exit devices to insure proper clearances.

R. Substitutions: Under provisions of Section 01600.

2.2 KEYING

- A. All locks shall be capable of accepting minimum six (6) pin cores and cylinders matching the Owner's present system, master keyed to Owner's approved system.
- B. Supply keys in the following quantities:
 1. 4 keys per cylinders, plus:
 2. 4 master keys.
 3. 4 grand master keys.

2.3 FINISHES

- A. Finishes: Satin chrome, U.S. 32D or 26D, when U.S. 32D is not available, unless otherwise noted in hardware product descriptions or schedule.
- B. All hardware screws, fasteners, etc. shall be Type 304 stainless steel.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that doors and frames are ready to receive work and dimensions are as indicated on shop drawings and instructed by the manufacturer.

3.2 INSTALLATION

- A. Install hardware in accordance with manufacturer's instructions.
- B. Use templates provided by hardware item manufacturer.
- C. Mounting heights for hardware from finished floor to center line of hardware item shall be per current State of Michigan, Barrier Free Code requirements.
- D. All thresholds shall be set in 2 continuous beads of sealant.

3.3 FIELD QUALITY CONTROL

- A. Field inspection will be performed under provisions of Section 01400.

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B. Architectural Hardware

1. Consultant to inspect installation and certify that hardware and installation has been furnished and installed in accordance with manufacturer's instructions and as specified.
2. Contractor shall submit a letter from the Architectural Hardware Consultant certify the installation.

3.4 ADJUSTING

- A. Adjust work under provisions of Section 01700.
- B. Adjust hardware for smooth operation.

3.5 PROTECTION OF FINISHED WORK

- A. Protect finished Work under provisions of Section 01500.
- B. Do not permit adjacent work to damage hardware or finish.

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3.6 SCHEDULE

Set 01

Hinge – Piano Hinge	Mortise Lockset – Classroom Function	Closer	Kickplate
Lock Protector	Threshold	Weatherstripping	

Set 02

Hinge – 2 Pair per Leaf (minimum)	Mortise Lockset – Classroom Function	Closer (Active Leaf)	Kickplate (Both Leaves)
Lock Protector	Threshold	Weatherstripping	Astragal
Overhead Holder (Inactive Leaf)	Flush Bolts (Inactive Leaf)		

Set 03

Hinge – Piano Hinge, all leafs	Mortise Lockset – Classroom Function		Kickplate (Both Bottom Leaves)
Lock Protector (Active Door Leaf)	Threshold	Weatherstripping	Astragal – at Both Doors and Operable Panels
Surface Bolt (Both Door Leafs)	Chain Bolts (Operable Panels)	Custom Monorail Cutout	Overhead Holder (Both Operable Panels)

Set 04

Hinge – 2 Pair	Anod. Aluminum Push/Pull Bars – coordinate w/ Storefront Mfr.; Provide heavy duty deadlatch with paddle at interior side of door	Closer	
	Threshold	Weatherstripping	

Set 05

Hinge – 2 Pair	Anod. Aluminum Push/Pull Bars – coordinate w/ Storefront Mfr.; No lockset, passage only function	Closer	
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Set 06

Hinge – 1 1/2 Pair	Mortise Lockset – Passage Function	Closer	Kickplate
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Set 07

Hinge – 1 1/2 Pair	Standard Lockset – Bath Privacy Function	Closer	Kickplate
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Set 08

Hinge – 1 1/2 Pair per Leaf	Standard Lockset – Storeroom Function	Flush Bolts (Inactive Leaf)	Kickplate (Both Leaves, Both Sides of Doors)
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Set 09

Hinge – 1 1/2 Pair	Standard Lockset – Office Function		Kickplate
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Set 10

Hinge – 1 1/2 Pair	Standard Lockset – Store Room Function		Kickplate
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END OF SECTION

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SECTION 08800

GLAZING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Glass and glazing for hollow metal work.

1.2 RELATED SECTIONS

- A. Section 07900 - Joint Sealers: Sealant and back-up material.
- B. Section 08225 – FRP Flush Panel Doors: Glazed doors.

1.3 REFERENCES

- A. ANSI Z97.1 - Safety Performance Specifications and Methods of Test for Safety Glazing Used in Buildings.
- B. ASTM C669 - Glazing Compounds for Back Bedding and Face Glazing of Metal Sash.
- C. ASTM C804 - Use of Solvent-Release Type Sealants.

1.4 SUBMITTALS

- A. Section 01300 - Submittals: Procedures for submittals.
- B. Certificates: Certify that Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the work of this section with three years experience.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Section 01600 - Material and Equipment: Environmental conditions affecting products on site.
- B. Do not install glazing when ambient temperature is less than 50 degrees F (10 degrees C).
- C. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.7 WARRANTY

- A. Section 01700 - Contract Closeout.

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PART 2 PRODUCTS

2.1 GLASS

- A. Interior glazing: 5/16" (8mm) thick laminated fire-rated and impact safety-rated glazing material. Rating shall comply with scheduled requirements.
- B. Exterior glazing: Insulated, tempered, Low-E, 1 inch thick, metal edge sealed units.
- C. Glass tint color shall be selected from Mfr. full range of available colors. Provide samples for review and approval.

2.2 GLASS MANUFACTURERS

- A. Guardian Industries
- B. PPG
- C. Tempglass Inc.
- D. Substitutions: Refer to Section 01300.

2.3 GLAZING

- A. Sash manufacturer's standard dry system using flexible gasket & silicone cap bead.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01039 - Coordination and Meetings: Verification of existing conditions before starting work.
- B. Verify that openings for glazing are correctly sized and within tolerance.
- C. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and ready to receive glazing.

3.2 PREPARATION

- A. Clean contact surfaces with solvent and wipe dry.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- C. Prime surfaces scheduled to receive sealant.
- D. Install sealant in accordance with manufacturer's instructions.

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3.3 INSTALLATION

- A. Place setting blocks at 1/4 points with edge block no more than 6 inches (150 mm) from corners.
- B. Rest glazing on setting blocks.
- C. Install spacer shims or preshimmed tape inserted between glazing and door frame as required to secure glass, 1/4 inch (6 mm) below sight line.
- D. Fill gaps between pane and shims with continuous, gunnable sealant to depth equal to bite on glazing with bevel or watershed away from glass.

3.4 FIELD QUALITY CONTROL

- A. Section 01400 - Quality Control: Field inspection.
- B. Inspection will monitor quality of glazing.

3.5 CLEANING

- A. Section 01700 - Contract Closeout: Cleaning installed work.
- B. Remove glazing materials from finish surfaces.
- C. Remove labels after Work is complete.
- D. Clean glass and adjacent surfaces.

3.6 PROTECTION OF FINISHED WORK

- A. Section 01700 - Contract Closeout: Protecting installed work.
- B. After installation, mark pane with an 'X' by using removable plastic tape or paste.

END OF SECTION

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SECTION 09900

PAINTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Surface preparation and field application of paints and coatings.
- B. New surfaces and construction shall be painted. Existing surfaces and areas shall be painted as called for on the Drawings.

1.2 RELATED SECTIONS

- A. Section 04300 – Unit Masonry System
- B. Section 05500 - Metal Fabrications
- C. Section 08331 – Overhead Insulated Doors

1.3 REFERENCES

- A. ASTM D16 - Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products.
- B. AWWA (American Water Works Association) - D102-17 - Painting Steel Water Storage Tanks.
- C. International Concrete Repair Institute (ICRI) Guideline No. 310.2-R2013 - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
- D. NACE (NACE International) -Industrial Maintenance Painting.
- E. SSPC (SSPC: The Society for Protective Coatings) SSPC Painting Manual Volumes 1 and 2.
- F. NAPF (National Association of Pipe Fabricators) Section 500 Surface Preparation Standards.

1.4 DEFINITIONS

- A. Conform to ASTM D16 for interpretation of terms used in this Section.

1.5 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide data on all products and special coatings. Data shall include manufacturer's suggested surface preparation and coating thicknesses.
- C. Samples: Submit two samples, 1 x 3 inch (25 x 76 mm) in size illustrating range of colors and textures available for each surface finishing product scheduled.

- D. Manufacturer's Instructions: Indicate special surface preparation procedures, substrate conditions requiring special attention, environmental considerations and any restrictions regarding time recoat.
- E. A letter certifying the installer as a Manufacturer's Approved Installer shall accompany the submittal package.
- F. Daily Coating Inspection Reports (blank version included at the end of this Section) are to be submitted weekly to Architect/Engineer. One report is to be completed for each day of painting activity performed on the job site. Reports must be fully filled out. Payment may be withheld if reports are not submitted in a timely fashion or are not fully completed.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section and one of the companies listed.
- B. Applicator: Company specializing in performing the work of this section with minimum ten years, approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 01600.
- B. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- C. Container label to include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- D. Only materials approved for use on this project shall be delivered to the site.
- E. Store paint materials at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.
 - 1. Any material found on the project that is stored in areas that are outside of the above temperature requirements shall not be used on the project and shall immediately be removed from the site.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the coating product manufacturer.
- B. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.
- C. Minimum Application Temperatures for Latex Paints:
 - 1. Minimum application temperatures shall be as required by the coating manufacturer's instructions.
 - 2. If there are no explicit printed recommendations by the manufacturer, minimum temperature of the air and surface to be painted shall be 50° Fahrenheit.

- D. Provide lighting level of 80 ft candles (860 lx) measured mid-height at substrate surface during coating operations in the area being painted.
- E. Provide adequate ventilation at all enclosed spaces. Additional ventilation may be required to prevent fumes from affecting adjacent Owner-occupied spaces.

1.9 SURFACES NOT REQUIRING PAINTING

- A. Aluminum (except for backcoating as specified in Section 3.2F).
- B. Stainless Steel.
- C. Copper.
- D. FRP.
- E. PVC, CPVC, HDPE and Fiberglass Pipe and Ductwork (including hangers).
- F. PVC Coated Electrical Conduit.
- G. Inside of pipe spaces, duct shafts, and similar areas not exposed to view.
- H. Exterior galvanized grating or checkered plate need not be painted, except to meet MIOSHA requirements.

1.10 EXISTING PAINTED SURFACES

- A. A recent lead paint survey is included in the project documents for reference. Existing painted surfaces that will be affected by project activities are to be abated in accordance with all federal, state and local regulations and guidelines as part of this work scope. Provide documentation of compliance methods to Owner for record as part of submittals.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers - Paint and Special Coatings
 - 1. Tnemec Company
 - 2. Carboline Company
 - 3. Sherwin-Williams Company
- B. Substitutions: No substitutions are allowed.
- C. All products used on this project shall be from the same manufacturer unless written approval is received from the Engineer.

2.2 MATERIALS

- A. Coatings:
 - 1. Ready mixed, except field catalyzed coatings.

2. Process pigments to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating; good flow and brushing properties; capable of drying or curing free of streaks or sags.

B. Accessory Materials:

1. As recommended by the manufacturer and required to achieve the finishes specified, of commercial quality.

C. Patching Materials:

1. Latex filler.

2.3 FINISHES

- A. Refer to schedule at end of section for surface finish schedule.
- B. Colors will be selected by the Owner from color samples submitted.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify site conditions under provisions of the General Conditions.
- B. Verify that surfaces and/or substrate conditions are ready to receive work as instructed by the product manufacturer.
- C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- D. Commencement of the coating operations will signify acceptance of the substrate(s) as being suitable for the coating and ability to achieve the final results specified.
- E. Test shop applied primer for compatibility with subsequent cover materials.
- F. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 1. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
 2. Concrete Floors: 8 percent. Test concrete for moisture in accordance with ASTM F 2170.

3.2 PREPARATION

- A. Remove electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.
- B. Correct defects and clean surfaces which affect work of this section.
 1. Remove existing coatings that exhibit loose surface defects.
- C. Marks:
 1. Seal with a stain-blocking primer marks which may bleed through surface finishes.
- D. Mildewed Surfaces:

1. Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach.
 2. Rinse with clean water and allow surface to dry.
- E. Aluminum Surfaces shall be backcoated with an Owner approved epoxy/sealer (Tnemec Series N69 or Carboline Rustbond penetrating sealer; or Sherwin-Williams Macropoxy 646) prior to installation to provide separation of dissimilar materials.
1. Contractor shall note that all dissimilar materials shall be kept from direct contact by the use of approved insulating and isolating materials.
 2. All surfaces shall be clean and if necessary treated with Clean'n Etch, Great Lakes Laboratories – Livonia, Michigan.
- F. Asphalt, Creosote, or Bituminous Surfaces Scheduled for Paint Finish:
1. Remove foreign particles to permit adhesion of finishing materials.
 2. Apply compatible sealer or primer.
- G. Insulated Coverings: Remove dirt, grease, and oil from surfaces.
- H. Fiberglass, PVC, CPVC or HDPE piping and connected items as shown on the drawings shall remain unpainted.
1. However, stenciled painted arrows, color bands, etc. shall be provided to agree with the Owner's Standard Color Code.
 2. Surface shall be lightly sanded below code markings prior to painting to obtain a roughened surface.
 3. Surface shall then be wiped with approved thinner solution.
 4. Markings shall then be applied as soon as the thinner has dried.
- I. Galvanized Surfaces Priming:
1. Galvanized surfaces scheduled for painting shall not be water quenched at the end of the galvanizing process.
 2. Remove gloss from the new spangled galvanizing by sweep blasting in accordance with the SSPC SP-16 – Brush Off Blast Cleaning of Coated or Uncoated Galvanized Steel, Stainless Steel and Non-Ferrous Metals.
 - a. Non-abrasive organic blasting media shall be utilized.
 - b. Environmental conditions shall be maximum 50% relative humidity and minimum piece and room temperature of 70 degrees F.
 3. Once prepared, galvanized surfaces are to be treated with Great Lakes Laboratories “Clean ‘n Etch” in accordance with Manufacturer’s requirements.
 4. Cleaned surfaces shall not remain overnight without a prime coat.
- J. Galvanized Surface Repair:
1. Damaged or welded galvanized areas shall have the galvanizing repaired in accordance with the current edition of ASTM A780.
 - a. Areas shall be repaired utilizing zinc-rich paints containing <80% zinc dust by weight of cured film.
 - b. Paint shall be stirred periodically in accordance with the manufacturer’s recommendations to maintain the zinc in suspension.
 - c. The repair areas shall be painted with a brush, spray painting will not be allowed.
 2. Abraded galvanized areas shall be spot primed with a cold galvanizing compound, Tnemec 90G-1K97 Tneme-Zinc, Carbozinc 11 HSN Carboline, Sherwin-Williams Zinc Clad 5 (aerosol), or ZRC product with 95% pure zinc dust.

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3. Spot prime all abraded galvanized areas not primed by other trades, to present a complete, protected area, to receive finish coats.

K. Concrete and Unit Masonry Surfaces:

1. Prepare all cementitious substrates referencing SSPC-SP13.
2. Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter.
3. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry.
4. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water.
5. Allow to dry.
6. Application of block filler will be by roller or brush.
7. Spraying will not be allowed.

L. Ductile Iron:

1. Remove grease, dirt, and other visible contaminants by washing with solvent (NAPF 500-03-01).
2. Where mill scale, weld spatter, and rust are evident, remove by power tool wire brushing (NAPF 500-03-03) or where required, abrasive blast cleaning (NAPF 500-03-04 and 500-03-05).
3. Spot prime paint after repairs.
4. Actual surface preparation procedure shall be based on approved coating manufacturer's published recommendations.

M. Shop Primed Steel Surfaces:

1. Prepare surfaces per SSPC 2/3 hand or power tool cleaning. Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous.
2. Clean surfaces with solvent.
3. Prime bare steel surfaces.
4. Prime metal items including shop primed items.

N. Mechanical Equipment components to be field painted are to be pre-coated on site prior to assembly.

3.3 APPLICATION

- A. Apply products in accordance with manufacturer's instructions.
- B. Apply each coat to uniform finish.
- C. Do not apply signs or pipe/equipment labels, etc. prior to installing coatings.
- D. Insulated pipe, fittings and equipment without an approved surface material or color shall be painted with 2 coats of Tnemec Series 115 Uni-Bond DF, Carboline Carbocrylic 3359, Sherwin-Williams Shercryl HPA which complies with the Color Code prescribed herein.
- E. Material labels and accompanying direction of flow arrows shall be applied to all distribution mains on maximum spacing of 50'.
 1. They shall be placed at those points on all main lines where branch mains are extended therefrom, and on the distribution mains at both sides of all solid building partitions.
 2. Material labels and flow arrows shall be custom made for all piping systems governed by this contract, signifying the kind of material to be conducted and its direction of flow.

3. All labels shall be self-adhesive and suitably coated to make them waterproof, and impervious to dirt.
 4. These labels shall have the identifying names superimposed on an Owner's approved background color in full or abbreviated, to meet the Owner's requirements and print the width of the label.
- F. Where letters and arrows cannot be applied to pipe lines, they shall be applied to metal panels, and in a manner to agree with identification listed in the Color Code.
1. Panels shall be 18 gage painted steel and hung on pipes every 50', near branch line connections and on either side of solid building partitions that pipes pass thru.
 2. On lines where there is flow in both directions, double arrows shall be used.
 3. On pipes where there is flow in one direction, single arrows shall be used.
- G. Substation equipment, control panels, panel boards, and other equipment specified to receive factory finish shall not be painted.
1. However, factory painted equipment which is chipped or defaced due to handling, installation or construction activities shall be refinished in a manner satisfactory to the Owner.
 2. This shall include glazing, sanding, and refinishing entire surface to a suitable boundary to avoid a patched effect.
 3. Suitable boundaries shall be changes in planes of surfaces such as corners, frames, mouldings, recesses, etc.
- H. Hazardous areas, moving machinery, handrails, and all other similar areas shall be finished to agree with the Owner's Standard Safety Code and all MIOSHA requirements, as approved by the Owner.
- I. Refer to Section 16195 for information on Electrical Identification requirements.
1. Refer to the end of this Section for color coding and identification banding of equipment, duct work, and piping.
- J. Paint shop primed equipment.
- K. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- L. Prime and paint exposed pipes, conduit, boxes, ducts, hangers, brackets, collars and supports.
- M. Paint dampers exposed behind louvers, grilles, to match face panels.
- N. Paint exposed conduit and electrical equipment occurring in painted areas.
- O. Paint both sides and edges of plywood backboards before installing equipment.
- P. Color code equipment, piping, conduit, and exposed duct work in accordance with requirements indicated.
1. Color band and identify with flow arrows and names, to match the existing installation.
- Q. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

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3.4 FIELD QUALITY CONTROL

- A. Contractor shall refer to the SSPC Paint Inspection: Daily Coating Inspection Report that is a part of this section of the Specifications
 - 1. This report shall be filled out daily for every day that the painter is on site and working.
 - 2. The reports shall be filled out in their entirety as applicable for the work being performed.
 - 3. Provide multiple reports if necessary because the work for the day will include several coatings so each paint/coating type is properly documented.
 - 4. All reports shall be available to the Owner and the Owner's representative upon request at the site.
 - 5. Copies of these daily reports shall be submitted within (7) seven days from date of work for all painting and coating work performed on this project.
 - 6. Failure to submit reports in a timely fashion or deficient reports shall be reason to not approve the requested payment for the work.
- B. Field inspection and testing will be performed under provisions of Section 01400.
- C. Areas will be tested at random with dry film thickness gage.
 - 1. Any areas not meeting the minimum dry film thickness shown in the schedule or on approved Shop Drawing submittals shall have additional coats applied so the minimum dry film thickness is achieved.
 - 2. Each coat shall achieve the minimum dry film thickness specified, without regards to the overall system thickness.
- D. If an existing surface or area is not called out for painting but is defaced or damaged due to new Work under this Contract, then this surface or area shall be repainted to match adjacent areas, at no additional cost to the Owner.
 - 1. Repair areas shall be to a suitable area boundary as determined by the Engineer in the field.
 - 2. A repaired area may include an entire wall or the entire floor in a room or gallery.
 - 3. Patched effect repairs shall not be acceptable.

3.5 CLEANING

- A. Clean work under provisions of 01700.
- B. Collect waste material, place in closed metal containers and remove daily from site.
- C. Make good all damage done to floors and other work through neglect or carelessness or from failure to properly protect work from damage resulting from the execution of this work.

3.6 SCHEDULE - ALL INTERIOR AND EXTERIOR SURFACES

Paint System	Surfaces
1	Exterior/Interior Ferrous Metals, Piping and Equipment
3A	Interior Masonry Units
3B	Interior exposed precast and poured in place concrete, including interior concrete wall surfaces below grade (not specified elsewhere).
6A	Submerged & Below Grade Buried Ferrous Mechanical Equipment Components and Piping (Non-Coal Tar)

- A. All painted walls, without applied base, shall be scribed 4" and painted with a 4" high, gloss black base.
 - 1. Material for base shall be compatible with the wall material.
- B. Aluminum Surfaces shall be backcoated with an Owner approved epoxy/sealer. Refer to Section 3.2.E of this Painting Specification.

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3.7 PAINTING - SYSTEMS
(Contractor shall refer to Products Section herein with regard to acceptable material manufacturers.)

- A. PAINTING SYSTEM NO. 1 –Exterior/Interior Ferrous Metals, Piping and Equipment
1. Surface Preparation, Ductile Iron Pipe – NAPF 500-03-04
 2. Surface Preparation, Ductile Iron Valves and Fittings – NAPF 500-03-05
 3. Surface Preparation, Galvanized Steel – SSPC-SP 16 and Clean ‘n Etch
 4. Surface Preparation, All Other Surfaces – SSPC-SP 6

	Min. No. of Coats per Coating Layer	Product Name	Min. Total Thickness of Coating Layer Dry	Type
Primer	1	Tnemec Series N69	4.0	Polyamide Epoxy
Intermediate	1	Tnemec Series N69	4.0	Polyamide Epoxy
Finish	1	Tnemec 1075 Endura Shield	3.0	Aliphatic/ Acrylic Polyurethane
Primer	1	Carboline Carboguard 890	4.0	Cycloaliphatic Amine Epoxy
Intermediate	1	Carboline Carboguard 890	4.0	Cycloaliphatic Amine Epoxy
Finish	1	Carboline Carbothane 134 HG	3.0	Aliphatic Polyurethane
Primer	1	Sherwin-Williams Macropoxy 646	4.0	Polyamide Epoxy
Intermediate	1	Sherwin-Williams Macropoxy 646	4.0	Polyamide Epoxy
Finish	1	Sherwin-Williams Acrolon 218	3.0	Aliphatic Polyurethane

CONTRACTOR shall choose one of Primer-Intermediate-Finish systems listed above.
Total Thickness of System – 11.0 Dry Mils Min.
CONTRACTOR shall note curing times required between coats, per actual product used.

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- B. PAINTING SYSTEM NO. 3A – New and Existing Interior Masonry units
1. Surface Preparation - SSPC-SP 13/NACE 6. Remove loose and flaking paint, feather edges. Abrade soundly adhered coating to remove gloss.

	Min. No. of Coats per Coating Layer	Product Name	Min. Total Thickness of Coating Layer Dry	Type
Undercoat	1	Tnemec 130-6602 Envirofill	60-80 s.f. gal.	Waterborne Cementitious Acrylic
Primer	1	Tnemec Series N69 Epoxoline	4.0	Polyamide Epoxy
Finish	1	Tnemec 1075 Endura Shield	4.0	Aliphatic/ Acrylic Polyurethane
Undercoat	1	Carboline Sanitile 500 Block Filler	60-100 s.f. gal.	Water Based Epoxy Filler
Primer	1	Carboline Carboguard 890	4.0	Cycloaliphatic Amine Epoxy
Finish	1	Carboline Carboguard 134 HG	4.0	Aliphatic Polyurethane
Undercoat	1	Sherwin-Williams Cement-Plex 875	60-100 s.f. gal.	Cementitious Waterborne Block filler
Primer	1	Sherwin-Williams Macropoxy 646	4.0	Polyamide Epoxy
Finish	1	Sherwin-Williams Acrolon 218	4.0	Aliphatic Polyurethane
<p>CONTRACTOR shall choose one of Undercoat-Primer-Finish systems listed above. <i>Undercoat not required at existing or previously painted masonry.</i> Total Thickness of System – 8.0 Dry Mills Minimum over filled surface.</p>				

- C. PAINTING SYSTEM No. 3B - Interior exposed precast and poured in place concrete
1. Surface Preparation - Same as above
Primer and Finish - Same as above, but without Undercoat
Total Thickness of System – 8.0 Dry Mills Min.

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- D. PAINTING SYSTEM NO. 3C – Existing Interior Glazed Masonry Units and Tile
1. Surface Preparation - Thoroughly and uniformly abrade to generate a minimum 1.0 mil profile. Use Filler/Patching product as needed to prepare surfaces as required.
 2. *Provide Satin or Semi-gloss sheen for Finish coat.*

	Min. No. of Coats per Coating Layer	Product Name	Min. Total Thickness of Coating Layer Dry	Type
Undercoat	1	Tnemec 215 Surfacing Epoxy	--	Polyamine Epoxy
Primer	1	Tnemec Series 113 H.B. Tneme-Tufcoat	4.0	Acrylic Epoxy
Finish	1	Tnemec Series 113 H.B. Tneme-Tufcoat	4.0	Acrylic Epoxy
Undercoat	1	Carboline Sanitile 500 Surfacing Epoxy	--	Epoxy
Primer	1	Carboline Sanitile 120	2.0	Waterbourne Acrylic
Finish	2	Carboline Sanitile 255	3.0	Acrylic Epoxy
Undercoat	0	Sherwin Williams		Not Applicable
Primer	1	Sherwin-Williams Extreme Bond Interior/ Exterior Bonding Primer	2.0	Urethane Modified Acrylic
Finish	2	Sherwin-Williams Pro Industrial Water Based Catalyzed Epoxy	3.0	Acrylic Epoxy
<p>CONTRACTOR shall choose one of Undercoat-Primer-Finish systems listed above. Total Thickness of System – 8.0 Dry Mils Minimum over filled surface.</p>				

E. PAINTING SYSTEM NO. 6A - Submerged & Below Grade Buried Ferrous Mechanical Equipment Components and Piping (non-potable) (Non Coal Tar)

1. Surface preparation, Submerged Ferrous Metal - SSPC-SP10
2. Surface preparation, Below Grade Ferrous Metal – SSPC-SP16 and Clean ‘n Etch
3. Surface preparation, Ductile Iron Pipe – NAPF 500-03-04
4. Surface Preparation, Ductile Iron Valves and Fittings – NAPF 500-03-05

	Min. No. of Coats per Coating Layer	Product Name	Min. Total Thickness of Coating Layer Dry	Type
Finish	1	G435 Perma-Glaze	40.0	Modified Polyamide Epoxy
Finish	1	Carboline Plasite 4550 S	40.0	Reinforced Epoxy Novolac
		or		
Finish	2	Carboline Phenoline Tank Shield	20.0	Phenolic Epoxy Novolac
Finish	1	Sherwin-Williams Dura-Plate 6000	40.0	Reinforced Epoxy
<p>CONTRACTOR shall choose one of Finish systems listed above. Total Thickness of System – 40.0 Dry Mills Min.</p>				

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3.8 SCHEDULE -EQUIPMENT COLORS

<u>EQUIPMENT</u>	<u>COLOR</u>
A. Blowers	*
B. Compressors	*
C. Couplings	Yellow
D. Cranes (Hoists)	Yellow
E. Blocks	Yellow and Capacity in Black
F. Fans	Orange
G. Flow Meters	*
H. Gear Reducers	Yellow
I. Guards	Orange
J. Motors	Orange
K. Pumps	*
L. Screens	*
M. Switch Enclosure	Orange
N. Tanks	*
O. Valves	*
P. Valve Operators	Yellow
Q. Handrail/Guardrail	Orange **
R. Handrail/Guardrail-Removable	Yellow & Black **
S. Fire Protection Equipment	Red
T. Emergency Stop Bars, Buttons, Etc.	Red
U. First Aid Kits and Enclosures-	
a. containing First Aid Equipment	Green
V. Safety Showers, Face Washes, etc.	
a. (Area Around)	Green
W. Transformers	Orange
X. Switchgear	Grey or Buff
Y. Misc. Metal	Black (unless otherwise noted)

- AA. * Color will depend on service. The color will be obtained from the "PIPE COLOR CODE" for the service. (No stripes used on equipment.)
- BB ** Brass, aluminum or stainless steel need NOT be painted.

The following colors shall be in conformity with the current ANSI Z553.1-2006 as referred to by MIOSHA.

1. Red
2. Orange
3. Yellow
4. Green
5. Blue
6. Purple
7. Black
8. White

Note: Colors shall meet the tests specified in Section 3, Color Definitions, of the current ANSI/NEMA Z535.1

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3.9 SCHEDULE -PIPING COLORS

<u>SERVICE</u>	<u>COLOR</u>	<u>STRIPE</u>
A. Potable Water – Cold	Green	
B. Potable Water – Hot	Green	Aluminum (1)
C. Emergency Shower Water	Green	Yellow (1)
D. Flushing Water	Gray	Blue (1)
E. Decant Water	Gray	White (1)
F. Industrial Water	Blue	
G. Ground Water	Blue	Green (1)
H. Instrument Air	Purple	Blue (1)
I. Natural Gas	Yellow	
J. Vacuum	Purple	Aluminum (1)
K. Roof Conductors	Match Background	
L. Floor Drains	Match Background	
M. Sump Pump Discharge	Gray	Black (1)
N. Sanitary Drains & Vents	Black	
O. Raw Sewage or Waste Water	Gray	
P. Sample Lines	Match System Being Sampled	
Q. Electrical Conduit	Match Background	
R. Stainless Steel		6" band with 3/4" stripes at 1"
S. Copper		6" band with 3/4" stripes at 1"
T. Plastic		6" band with 3/4" stripes at 1"
U. Low Pressure Air	per Owner	
V. Compressed Air	per Owner	
W. Grit	per Owner	
X. Sludge	per Owner	

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END OF SECTION

**Paint Inspection:
Daily Coating Inspection Report**

Date: / / M T W Th F S Su		Pg. Of
Project #:		COPY To:
Inspector:		<input type="checkbox"/> QC Mgr <input type="checkbox"/> Owner
Project/Client:		<input type="checkbox"/> Contr <input type="checkbox"/> _____
Location:		Attachments:
Description:		<input type="checkbox"/> DFT Sheet <input type="checkbox"/> NCR/CAR
Requirements:		<input type="checkbox"/> _____
Contractor:		Revision #
Description of Areas & Work Performed		Hold Point Inspections Performed
		<input type="checkbox"/> 1 Pre Surface Prep/Condition & Cleanliness
		<input type="checkbox"/> 2 Surface Preparation Monitoring
		<input type="checkbox"/> 3 Post Surface Preparation/Cleanliness & Profile
		<input type="checkbox"/> 4 Pre Application Prep/Surface Cleanliness
		<input type="checkbox"/> 5 Application Monitoring/Wet Film Thickness (WFT)
		<input type="checkbox"/> 6 Post Application/Application Defects
		<input type="checkbox"/> 7 Post Cure/Dry Film Thickness (DFT)
		<input type="checkbox"/> 8 Nonconformance/Corrective Actions Follow-up
		<input type="checkbox"/> 9 Final Inspection
		Approved By: _____
Surface Conditions		Ambient Conditions
<input type="checkbox"/> New <input type="checkbox"/> Maint <input type="checkbox"/> Primer/Paint <input type="checkbox"/> Age/Dry/Cure _____		Time (Indicate AM or PM) : : : :
<input type="checkbox"/> Steel <input type="checkbox"/> Galvanize <input type="checkbox"/> Concrete <input type="checkbox"/> Other _____		Dry Bulb Temp ^o (C/F) : : : :
<input type="checkbox"/> Hazard _____ <input type="checkbox"/> Sample Report # _____		Wet Bulb Temp ^o (C/F) : : : :
<input type="checkbox"/> Degree of contamination: _____		% Relative Humidity : % : % : % : %
Test: <input type="checkbox"/> Cl _____ µg/cm ² / ppm <input type="checkbox"/> Fe _____ ppm <input type="checkbox"/> pH _____		Surface Temp ^o (C/F) Min/Max : / : / : / : /
<input type="checkbox"/> Degree of Corrosion: _____		Dew Point Temp ^o (C/F) : : : :
<input type="checkbox"/> Scale <input type="checkbox"/> Pitting/Holes <input type="checkbox"/> Crevices <input type="checkbox"/> Sharp Edges		Wind Direction/Speed : : : :
<input type="checkbox"/> Weld _____ <input type="checkbox"/> Moisture <input type="checkbox"/> Oils <input type="checkbox"/> Other _____		Weather Conditions: : : : :
<input type="checkbox"/> Painted Surface Condition: _____		Application
Dry to: <input type="checkbox"/> Touch <input type="checkbox"/> Handle <input type="checkbox"/> Recoat		Start Time : Finish Time : Est. Sq/ft.
<input type="checkbox"/> Dry/Over Spray <input type="checkbox"/> Runs/Sags <input type="checkbox"/> Pinholes <input type="checkbox"/> Holidays		<input type="checkbox"/> Primer <input type="checkbox"/> Intermediate <input type="checkbox"/> Topcoat <input type="checkbox"/> Touch-up
<input type="checkbox"/> Abrasion <input type="checkbox"/> Fall Out <input type="checkbox"/> Other _____		Generic Type: Qty Mixed:
Surface Preparation		Manuf.: Mix Ratio:
Start Time: Finish Time: Est Sq/ft:		Prod Name: Mix Method:
<input type="checkbox"/> Solvent Clean <input type="checkbox"/> Hand Tool <input type="checkbox"/> Power Tool		Prod #: Strain/Screen:
<input type="checkbox"/> HP Wash PSI _____ <input type="checkbox"/> Other _____		Color: Material Temp: °F
<input type="checkbox"/> Abrasive Blast <input type="checkbox"/> Abrasive Type _____ <input type="checkbox"/> Sample		Kit Sz/Cond.: Min/Hrs
<input type="checkbox"/> Blast Hose Size _____ <input type="checkbox"/> Nozzle Size / PSI _____		Shelf Life: Min/Hrs
<input type="checkbox"/> Air Supply CFM _____ <input type="checkbox"/> Air Supply Cleanliness		Batch #'s
<input type="checkbox"/> Water/Oil Trap Check <input type="checkbox"/> Equipment Condition Check		(A) Reducer #: Piv/Qt/Gal
		(B) Qty Added: %
		(C) % by Vol: %
		Specified WFT Avg: Mils
		Achieved WFT Avg: Mils
Surface Cleanliness & Profile Measurement		Reducer: <input type="checkbox"/> Airless/Conv. Spray <input type="checkbox"/> Brush <input type="checkbox"/> Roller <input type="checkbox"/> Other _____
<input type="checkbox"/> Job Specification <input type="checkbox"/> SSPC/NACE - SP- _____		Pump Pot Hose Dia. Air Check
<input type="checkbox"/> SSPC/NACE Spec / Visual Stds <input type="checkbox"/> _____		Ratio/Size Hose Lng. SEP/Trap
Profile Check: _____ <input type="checkbox"/> Disc <input type="checkbox"/> Tape <input type="checkbox"/> Gauge		GPM/CFM Spray Gun Filter
<input type="checkbox"/> Specified _____mils avg. / Achieved _____mils		PSI Tip Sz. Agitator
<input type="checkbox"/> Surface effect on DFT Gauge/BMR _____mils		
Dry Film Thickness		
Gage Type / Model	Gage Serial #	Gage Calib. Verified
Spec Avg. DFT	Total Avg DFT	DFT Last Coat
		DFT This Coat
Inspector's Signature		Date



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SECTION 11100

PUMPS - GENERAL

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, install, test, and make fully operational all pumping equipment, complete with all necessary accessories, in compliance with the Contract Documents.
- B. All pumping equipment shall be provided in accordance with the requirements of Section 15000, Equipment General.
- C. The provisions of this section shall apply to all pumps and pumping equipment specified except where specifically noted otherwise in the Contract Documents.
- D. The pumps shall be provided complete with all accessories, shims, sheaves, couplings, and other appurtenances as specified, and as may be required for a complete and operating installation.

1.2 SHOP DRAWINGS

- A. Shop Drawings shall include the following information in addition to the requirements of Section 01300, Submittals and Section 15000, Equipment General.
 - 1. Details of shaft sealing system
 - 2. Pump performance curves at rated speed and reduced speed (if reduced speeds are specified). Curves shall indicate flow, head, efficiency, brake horsepower, NPSH required, and minimum submergence. Curves shall include limits (minimum and maximum flows) for stable operation without cavitation, overheating, recirculation, or excessive vibration.
 - 3. General cutaway sections, materials, dimension of shaft projections, shaft and keyway dimensions, shaft diameter, dimension between bearings, general dimensions of pump, suction head bolt orientation, and anchor bolt locations and forces.
 - 4. Foundry certificates and results of Brinnell hardness testing showing compliance to ASTM A 532 (where required in the individual pump specifications).
 - 5. Submersible pump submittals shall also include:
 - a. Product data sheets for power and control cables and length of cables.
 - b. Details on pump guide rail system and mounting requirements.

PART 2 PRODUCTS

2.1 MATERIALS

- A. All materials employed in the pumping equipment shall be suitable for the intended application. Material not specifically called for shall be high-grade, standard commercial

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quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements unless otherwise specified in individual pumping equipment Specifications:

1. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A 48, or equal.
 2. Bronze pump impellers shall conform to ASTM B 584, "G" bronze.
 3. Stainless steel pump shafts shall be of Type 400, Series. Miscellaneous stainless steel parts shall be of Type 316.
- B. Suction and discharge flanges shall conform to ANSI standard B16.1 or B16.5 dimensions.
- C. Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

2.2 APPURTENANCES

- A. Pressure Gauges
1. The Contractor shall furnish and install pressure gauges on the suction and discharge of each pump, except wet-pit submersible pumps and vertical turbine pumps.
 2. The Contractor shall furnish and install pressure gauges on the discharge piping of each wet-pit submersible pump and vertical turbine pump in the locations shown on the Drawings or as directed by the Engineer.
 3. Suction gauges shall be of the single scale compound type to indicate both pressure and vacuum. Each suction gauge shall be graduated in feet of water over the span of 34 feet below and above zero.
 4. Discharge gauges shall be graduated in feet from zero to a minimum of five (5) feet of water above the respective pump shutoff head or to a minimum of 30% above the maximum operation pressure, whichever is greater. Graduation shall be in feet of water.
 5. All gauges shall be supplied by one manufacturer and shall be as specified in Section 17650, Pressure Gauges.
 6. All gauges shall be provided with diaphragm seals or isolating ring seals as specified in Section 17698, Instrumentation and Control Accessories.
- B. Flexible couplings for direct driven pumps shall be as manufactured by Falk, Dodge, Woods Corp., or equal and shall be furnished with guards in accordance with OSHA Rules and Regulations. Spacer couplings shall be provided where necessary to allow removal of the pump rotating element without disturbing the driver.

2.3 ELECTRICAL REQUIREMENTS

- A. All pumps shall be furnished with motors such that the motor shall not be overloaded throughout the full range of the pump operation, unless otherwise specifically approved by the Engineer.
- B. Where variable frequency drives (VFDs) are specified, the Contractor shall be responsible for coordinating between pump supplier and VFD supplier to ensure a complete and operational system. VFDs shall be furnished under Division 16 and shall be as specified in Section 16495, Low Voltage Variable Frequency Drive Systems.

- C. Motor starters and controls shall be furnished and installed under Division 16 and Division 17 unless otherwise specified in the individual pump specifications.

2.4 EQUIPMENT IDENTIFICATION

- A. In addition to the requirements of Section 15000, Equipment General, nameplate data for each pump shall include the rating in gallons per minute, rated head, speed, and efficiency at the primary design point.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Drains: All gland seals, air valves, and drains shall be piped to the nearest floor drain or trench drain with galvanized steel pipe or copper tube, properly supported with brackets.
- B. Solenoid Valves: Where required, the pump manufacturer shall furnish and install solenoid valves on the water or oil lubrication lines. Solenoid valve electrical rating shall be compatible with the motor control voltage and shall be furnished complete with all necessary conduit and wiring installation from control panel to solenoid.

3.2 SHOP TESTING

- A. Shop tests shall be performed in accordance with Section 15000, Equipment General and except where stated otherwise herein, shall be conducted in accordance with the latest version of Hydraulic Institute Standard 14.6, Hydraulic Performance Acceptance Tests.
- B. Pump testing shall be witnessed by the Owner/Engineer where specified in the individual pump specifications. The testing procedure shall be submitted to the Engineer for review before scheduling the testing. The Engineer shall be given at least 2 weeks advanced notice of the scheduled testing date.
- C. Certified test curves for shall be provided for all centrifugal pumps unless otherwise specified in the individual pump specifications. Certified tests will not be required for submersible sump pumps (as specified in Sections 11133) with motors less than 5 hp.
- D. Pumps shall be within the tolerances specified for Acceptance Grade 1U, in accordance with the latest version of Hydraulic Institute Standards 14.6.
- E. For wet pit submersible pumps and vertical turbine pumps, all tests shall be run at minimum pump submergence specified in the individual pump specifications.
- F. Where required in the individual pump specifications, each individual casting shall be Brinnell tested in a minimum of two places, in an area of representative casting thickness to ASTM Method E10. Results shall be certified by a registered professional ENGINEER. Test results shall verify the satisfaction of the required Brinnell hardness of the finished product as specified in respective subsections.

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3.3 FIELD TESTING

- A. Field tests shall be performed in accordance with in Section 15000, Equipment General and additionally as specified below and in the individual pump specifications.

- B. Final acceptance tests shall demonstrate the following:
 - 1. The pumps have been properly installed and are in proper alignment.
 - 2. The pumps operate without overheating or overloading of any parts and without objectionable vibration. Vibration shall be within the Hydraulic Institute limits, or manufacturer's limits if more stringent.
 - 3. The pumps can meet the specified operating conditions. All pumps shall be checked at maximum speed for a minimum of four points on the pump curve for capacity, head, and amperage. The rated motor nameplate current shall not be exceeded at any point. Pumps with drive motors rated at less than five horsepower shall only be tested for overcurrent when overheating or other malfunction becomes evident in general testing.

END OF SECTION

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SECTION 11112

HORIZONTAL RECESSED IMPELLER PUMPS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install horizontal recessed impeller pumps at the locations shown on the Drawings and as specified herein. All pumps shall be supplied by the same manufacturer.
- B. Equipment shall be provided in accordance with the requirements of Section 15000, General Equipment and Section 11100, Pumps - General.

1.2 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

A. **Grit Pumps No. 1 through No.4**

Number of Units	4
Primary Operating Point*	
Design Capacity (gpm)	250
Total Dynamic Head (feet)	31
Secondary Operating Point (additional point on the same curve)	
Design Capacity (gpm)	300
Total Dynamic Head (feet)	30
Shut Off Head, Minimum (ft)	50
Brake Horsepower, Maximum	15
Pump Efficiency, Minimum	25%
Pump Speed, Maximum (rpm)	1800
Temperature of Liquid Pumped	Ambient
Suction Condition	Flooded
Minimum Size of Solids (Spherical Diameter, inches)	3
Minimum Suction Diameter (inches)	3
Minimum Discharge Diameter (inches)	3

* Operating point shall be within 70% to 120% of the BEP flow rate for that speed.

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1.3 SUBMITTALS

- A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300, Submittals; Section 11100 and Section 15000, General Equipment:
1. Performance Affidavit
 2. Provide a copy of this specification section, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (☐) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the CONTRACTOR with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
 3. A copy of the Contract Document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this Section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
 4. Detailed mechanical and electrical drawings showing the equipment dimensions, locations of connections, weights of associated equipment and wiring diagrams. Mechanical drawing shall provide exploded view detail of pump components.
 5. Make, model, weight, and horsepower of each equipment assembly.
 6. Manufacturer's data, descriptive literature, bulletins, and catalogs indicating the general description, specifications, and limitations for collective system and individual components.
 7. Bill of Materials for equipment showing materials of construction and part numbers.
 8. Certified performance data curves showing head, capacity, NPSHr, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity.
 9. Motor nameplate data, as defined by NEMA MG 1, motor manufacturer, and including any motor modifications.
 10. Factory finish system.
- B. Informational Submittals:
1. Operation and Maintenance (O&M) Manuals (3 binders and 1 digital of final version)
 2. Warranty Certificate.
 3. Bearing L-10 life calculations.
 4. Installation Inspection Report
 5. Brinell Hardness Test Report
 6. Certification of satisfactory field testing of each unit as specified.

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PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Each pump shall be a horizontal, recessed impeller, single stage, end suction, non-clog, vortex type centrifugal pump, WEMCO Model "C". The substitution policy does not apply to this item.

2.2 MATERIALS

- A. Casing for the pumps shall be constructed of 28% Chrome Iron or Ni-Hard with a minimum thickness of 3/4 inch with normal casting tolerance. The pump casing shall be 2-piece, radially split-type, with a separate and removable (replaceable) suction designed so that the impeller can be withdrawn without the need to remove the discharge casing or disturb the discharge piping.
 - 1. A removable wear-plate of 28% Chrome Iron or Ni-Hard shall be provided in back of the impeller designed to direct flow from behind the impeller to the center of the volute for maximum protection to the casing. Casing and wearplate and suction cover shall have a minimum Brinell hardness of 650.
 - 2. The pump casing shall be so arranged that all rotating parts may be removed without disturbing either suction or discharge piping. No wearing rings or impeller faceplates shall be required.
 - 3. All casings shall be completely open from suction to discharge. All internal case clearances shall be equal to the discharge diameter so that all material which will pass through the discharge can pass through the pump.
- B. Suction and discharge connections shall be ANSI Standard flat faced 125 lb. flanges with slotted bolt circle and shall be drilled and tapped for gauge, drain, and vent connections or shall be self-venting. The necessary lifting bolts and eye lugs shall be provided for installation and maintenance of the pumps. Taps 1/2 inch diameter for gauge connections shall be provided on all nozzles. Gauges shall be furnished and installed under Section 11100, Pumps - General.
- C. The separate and removable (replaceable) suction cover shall be constructed of 28% Chrome Iron or NiHard with a minimum thickness of 1-1/4 inch with normal casting tolerance.
- D. The pump shall be of the recessed cup-type impeller design, with the impeller mounted completely out of the flow path between the pump inlet and discharge connections, so that solids are not required to flow through the impeller.
 - 1. The impeller shall be constructed of 28% Chrome Iron or Ni-Hard and shall be connected to the shaft and secured against reverse rotation. The impeller shall be hydraulically and dynamically balanced.
- E. Rotation of pumps shall be clockwise when viewed from the driven end, unless otherwise shown on the Drawings.
- F. Stuffing box cover shall be constructed of cast iron, ASTM A48, Class 25 and 35, and shall be designed with a machined self-centering fit with the pump casing. Stuffing box shall be readily accessible. Tapped holes shall be provided for oil or seal water connection as specified.

- G. Sealing shall be accomplished by a single mechanical seal. The single mechanical seal shall be a split mechanical seal, Model # 442 by Chesterton or equal. The stuffing box shall be designed to operate with seal flush water. The stuffing box shall be equipped with a restrictor bushing to minimize the amount of seal flush water. The mechanical seal shall consist of silicon carbide seal faces, ethylene propylene flexible members, and 316 stainless metal parts.
- H. Shaft shall be carbon steel, ASTM A108-Grade 1141 (minimum) and sufficiently large in diameter to transmit safely the maximum torque developed by the drive unit and of such design as to provide a rigid support for the impeller and to prevent excessive vibration. The shaft shall be ground and polished over its entire length and shall be protected through the stuffing box by a removable hardened stainless steel shaft sleeve with seal to prevent leakage.
- I. The shaft sleeve shall be constructed of 420 stainless steel hardened to 450 Brinell or better and secured to prevent reversal of rotation. An "O" ring seal shall be provided to prevent leakage under the sleeve.
- J. Bearings shall be of the radial and thrust bearings, antifriction ball or roller type, oil lubricated in a dust proof housing. Each thrust bearing shall be adjustable and all bearings shall be readily accessible and designed for convenient repair or replacement.
 - 1. Drain plugs shall be provided for the lubrication and cleaning of the bearings.
 - 2. Bearings shall be sized for a minimum AFBMA B-10 life of 100,000 hours under worst possible operating conditions.
 - 3. The bearing frame shall be of heavy cast iron and bolted to the frame adapter. The bearing frame shall contain a large oil reservoir. Oil level to be maintained at proper level by means of a constant level oiler. Oil level shall be monitored by a sight glass mounted integrally with the pump.
- K. The pump shall be supported by a cast iron pedestal cast integrally with, or especially fabricated for, the pump casing and sufficiently sized to ensure rigid support. The common pump and motor base shall be of heavy welded steel (minimum 3/8 inch thick) construction or cast iron suitably constructed to support the equipment and shall be provided with grout holes and drain connections with drip-lip.
- L. Each pump shall be driven by a constant speed motor through a V-belt and sheave arrangement to meet the design conditions outlined herein.
 - 1. The motor shall be mounted as shown in the Drawings on adjustable motor brackets.
 - 2. A variable speed sheave, Woods MS-type, or equal, shall be provided to obtain speed adjustment.
 - 3. An enclosed V-belt guard shall also be provided.
- M. Provide pressure gauges per Section 11100.

2.3 ELECTRICAL AND CONTROL REQUIREMENTS

- A. All electrical appurtenances furnished by the equipment manufacturer shall be rated for installation based on area classifications stated in the drawings.
- B. Electrical Requirements

	Grit Pumps No. 1 and No. 2	Grit Pump No. 3
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Motor		
Rating	460V, 3 ph, 60 Hz	460V, 3 ph, 60 Hz
Horsepower	20	20
Speed, rpm	1800	1800
Enclosure	TEFC	TENV
Insulation	Class F	Class F
Inverter Duty	No	No
Service Factor	1.15	1.15
Space Heater	Yes	Yes
Motor Winding Temperature Switches	Yes	Yes
Separate Cooling Fan	No	No

2.4 SPARE PARTS

- A. The spare parts which are identical and interchangeable with the original parts shall be furnished in clearly identifiable and labeled containers.
1. One (1) - drive V-belt
 2. Two spare mechanical seals

PART 3 EXECUTION

3.1 MANUFACTURER'S FIELD SERVICES

- A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 15000, Equipment General . For each series of pumps, field services shall include the following site visits:

Service	Number of Trips	Number of Days/Trip
Installation and Testing	1	1
Startup and Training	1	1

- B. Provide field tests per Section 11100.

END OF SECTION

SECTION 11133

SUBMERSIBLE SUMP PUMP

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install submersible non-clog sump pumps at the locations shown on the Drawings and as specified herein. All pumps shall be supplied by the same manufacturer.
- B. Equipment shall be provided in accordance with the requirements of Section 15000, Equipment General and Section 11100, Pumps - General.

1.2 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

	South Grit Pump Drywell	North Grit Auger Drywell	North Garage Room	Lower Alcove Area	South Garage
Arrangement	Duplex	Duplex	Duplex	Duplex	Duplex
Design Capacity (gpm)*	55	55	100	55	235
Total Dynamic Head (ft.)	19	20	20	17	13
Motor Horsepower (Max.)	1.0	1.0	1.0	1.0	1.0
Max. Pump Speed (rpm)	1800	1800	1800	1800	1800
Min. Size of Solids (in.)	0.5	0.5	0.5	0.5	0.5
Min. Discharge Diameter (in.)	2	2	2	2	2
Area Classification	Unclassified	Class I, Div. 1	Class I, Div. 1	Class I, Div. I	Class I, Div. I
Control Panel Rating	NEMA 4X	NEMA 7	NEMA 7	NEMA 7	NEMA 7

1.3 SUBMITTALS

- A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300, Submittals, 15000, Equipment General, and Section 11100, Pumps - General:
 1. Equipment and motor nameplate data
 2. Complete electrical schematic wiring diagram drawings.
 3. Copies of certified shop test reports.
 4. Spare Parts List
 5. Field test results.
 6. Certificates of installation.
 7. Performance Affidavit

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1.4 WARRANTY AND GUARANTEE

- A. The manufacturer will warrant against any defects in material or workmanship to the pump equipment. This warranty will commence upon delivery of the products and will expire on the earlier to occur of one (1) year from initial operation of the product or 18 months from delivery thereof (the "Warranty Period").

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. The pumps shall be submersible sewage pumps as manufactured by Flygt, Sulzer ABS, or Wilo-USA.

2.2 MATERIALS

- A. **Pump Construction** The lifting cover, stator housing, and volute casing shall be close grained cast iron conforming to ASTM A48 Class 25 through 35. All exposed nuts, bolts, washers, and other fastening devices shall be Type 304 stainless steel.
- B. Casing shall be completely open from suction to discharge with no wearing rings or impeller faceplates required. All internal case clearances shall be equal to the inlet diameter so that all materials which will pass through the inlet can pass through the pump.
- C. Impeller shall be cast iron construction and either the flow through or recessed design. The impeller shall be secured to the motor shaft per manufacturers recommendations.
- D. Shafting shall be constructed of either 400 series stainless steel or high grade carbon steel, Grade 1045 (minimum), for the pump and motor, and sufficiently large in diameter to transmit safely the maximum torque developed by the drive unit and of such a design as to provide a rigid support for the impeller and to prevent excessive vibration. The shaft shall be suitably heat treated, turned, ground, and polished over its entire length.
- E. Shaft Seal for the pump and motor shaft shall utilize a mechanical seal. The mechanical seal shall consist of carbon and ceramic seal faces running in an oil filled chamber to provide constant lubrication, BUNA N or ethylene propylene flexible members, brass or stainless steel metal parts and 18 8 stainless steel spring.
- F. Bearings shall be of the anti-friction ball or roller type. Bearings shall be heavy-duty, permanently oil lubricated which will carry all radial and axial thrust loads. Bearings shall have a minimum AFBMA B 10 life of 30,000 hours under worst possible operating conditions.

2.3 ELECTRICAL AND CONTROL REQUIREMENTS

- A. All electrical appurtenances shall be rated for installation in classified areas as indicated in the Sump Pump Schedule.
- B. Motors shall conform to all applicable parts of Section 15170. The pump motor shall be designed for 460 volt, 60 Hertz, three phase operation. See sump pump schedule for motor horsepower. Motors shall be mounted on each pump and shall conform to the latest applicable NEMA, IEEE, and ANSI standards for submersible service. The motors shall be rated for continuous duty with a minimum service factor of 1.15.
 - 1. The pump motor shall be squirrel cage induction type, housed in a watertight chamber.
 - 2. The stator winding and stator leads shall be moisture resistant.
 - 3. Insulation shall be manufacturer's premium grade Class F insulation rated 155 degrees Celsius, 40 degrees Celsius ambient plus 115 degrees Celsius rise. The stator shall be dipped and baked three times in Class F varnish and shall be heat shrink fitted into the stator housing.
 - 4. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing shall not be allowed.
 - 5. The motor shall be guaranteed for continuous unsubmerged duty, capable of sustaining a minimum of ten (10) starts per hour without overheating.
 - 6. The motor shall be provided with pre lubricated radial and thrust bearings which are designed to carry the entire load which may be imposed upon it under all operating conditions.
 - 7. All motors shall be of nationally known manufacture and shall be housed in enclosures specifically designed for submersible pump application.
- C. The cable entry water seal design shall insure a watertight and submersible seal.
 - 1. The junction chamber, containing the terminal board, shall be sealed from the motor by elastomer compression O ring seal.
 - 2. Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to a terminal board and thus perfectly leak proof.
- D. Power and control cables between the pumps and the control panel shall be provided by the pump manufacturer who shall be responsible for reviewing the electrical drawings as necessary to determine the required cable length. All pumps for the same application shall be provided with the same length of cable. No splices shall be allowed unless specifically called for in the electrical drawings. Cable shall be suitable for submersible pump applications and shall be sized according to NEC and ICEA standards. Stainless steel strain relief connectors shall be furnished for all cables.
- E. Float switches shall be provided with the pump controls. Float switches shall comply with requirements specified under Division 17, Control and Information System. Float switches shall be set and shall operate according to the sump pump schematic and installation details shown on the Drawings and as specified herein. A total of three float switches shall be provided with the sump pump controls: pumps off (low level), lead pump on, and lag pump

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on/high level alarm. Float switches to be installed in classified areas shall be intrinsically safe and suitable for use in the classified area as specified in the Sump Pump Schedule.

2.4 CONTROL PANELS

- A. Motor starters and controls for the 480 VAC, 3-phase sump pump installations shall be provided in a stainless steel control panel. NEMA rating of panel and appurtenances shall be as indicated in the Sump Pump Schedule. The control panels shall be assembled using NEMA rated components. Components designed and built to International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured and labeled in compliance with IEC standards is not acceptable.
- B. The control panel shall include, but not be limited to, the following:
 - 1. A single circuit breaker type lockable disconnect switch operable from outside the control panel.
 - 2. A motor circuit protector and full voltage nonreversing magnetic starter for each pump. The motor starter shall be NEMA Size 1 (minimum) for each pump.
 - 3. Each pump shall be provided with a Hand-Off-Auto (H-O-A) control switch on the front of the control panel with control in the automatic mode by float switches in the sump. Automatic controls for duplex installations shall also include automatic alternation of duty and standby pumps after each shutdown.
 - 4. Control power shall be 120 VAC from an integral, fused control power transformer.
 - 5. Each control panel for duplex installations shall include alarm/indication lights and legend plates on the front of the control panel for "high water level," "control power on", "lead pump on" and "lag pump on". The high level float switch for "lag pump on" shall activate a remote "sump high water alarm" through unpowered auxiliary alarm contacts.
 - 6. Each control panel for simplex installation shall include alarm/indication lights and legend plates on the front of the control panel for "high water level", "control power on", and "pump on". The high level float switch shall activate a remote "sump high water alarm" through unpowered auxiliary alarm contacts
 - 7. Panel shall have dry contacts for remote indication of the following conditions:
 - a. Run status for each pump.
 - b. Fault alarm for each pump.
 - c. High Level Alarm

	South Grit Pump Drywell	North Grit Auger Drywell	North Garage Room	Lower Alcove Area	South Garage
Top of Sump	EL 732.0	EL 731.5	EL 742.5	EL 734.5	EL 739.5
Lag Pump On and High Level Alarm After Adjustable (0-120 Sec) Time Delay	EL 731.8	EL 730.8	EL 729.6	EL 733.0	EL 738.0
Lead Pump On	EL 731.6	EL 730.1	EL 728.6	EL 732.5	EL 737.2
Pumps Off and Alternated *	EL 730.9	EL 729.4	EL 726.75	EL 731.25	EL 735.2
Bottom of Sump	EL 730.0	EL 728.5	EL 724.5	EL 728.5	EL 733.2

2.5 SPARE PARTS

- A. Spare parts shall be provided in accordance with 15000, Equipment General and shall include the following for each size pump:

PART 3 EXECUTION

3.1 MANUFACTURER'S FIELD SERVICES

- A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 15000, Equipment General.

Service	Number of Trips	Number of Days/Trip
Installation and Testing	1	1
Startup and Training	1	1

- END OF SECTION -

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SECTION 11283
SLIDE GATE REHABILITATION

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The existing screen isolation slide gates in the Headworks leak and require rehabilitation. The gates are Waterman. The O&M manuals are attached as Appendix A2 to the Contract Documents.
- B. The gate to be repaired are designated as:
 - 1. North Screen Channel: F-5-1, F-5-2, F-5-3, F-5-4, F-6-4, and F-3-1
 - 2. South Screen Channel: F-8-1, F-8-2, F-8-3, F-8-4, F-8-5, F-8-6, F-8-1 and R-9-1
 - 3. Emergency Bypass Channel: F-6-1, F-6-2 and F-6-3
 - 4. All other gates not listed are not in the contract.
- C. See Section 01950 3.5 for sequencing and further information.
- D. If fabricated repairs are required, - i.e. replacing gate frame elements, stem, or other gate components, - these will be handled as a changed condition.

1.2 SHOP DRAWINGS

- A. Shop Drawings for the existing gates are be provided.
- B. Provide submittals for replacement components

PART 2 PRODUCTS

2.1 MATERIALS

- A. All materials shall be supplied by the gate manufactures as OEM parts.
- B. Non-OEM parts will be accepted only if original parts are not available.

PART 3 EXECUTION

3.1 REHABILITATION

- A. Contractor shall replace the seats and seals for each gate. The replacement components are parts 1.e.1, 1.e.2, 1.d.1, and 1.d.2. It is intended to re-use part 1.c. See Appendix A2-O&M Manual for details. It is also assumed that the grout bed is intact. If this requires work, this will be a changed condition.
- B. Contractor to engage the services of Kennedy Industries as necessary to complete the work.
- C. Several gates will require temporary bulkheads or other means of isolation to rehabilitate the gates. (See Section 01950, 3.4) Gate isolation is considered means and methods. Provide isolation and shut down plan per 01300.

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- D. Contractor to remove or disassemble gate members as required to expose and remove the existing seats and seals for observations, and to confirm the replacement components. This work will be done in the presence of the Engineer.
- E. Contractor to submit similar replacement materials and products for approval. It is assumed that these replacement products will also be installed on the remaining gates
- F. The Contractor shall isolate, replace the stated parts, and test each of the gates.
- G. Rehabilitated gates shall meet twice the allowable AWWA spec, or 0.20 gpm /LF seating head or 0.30 gpm/LF unseating head. Test gates to determine leakage rate and re-perform work if required.

END OF SECTION

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SECTION 11350 (A)

MECHANICAL SCREENING PACKAGE - DUPERON

PART 1 GENERAL

1.1 SUMMARY

A. Screening

1. This section includes the furnishing of a front-cleaning, front-return link driven mechanically cleaned bar screen assembly and any auxiliary equipment or accessories to be installed in the location as indicated on the drawings and as specified herein.

Equipment Manufacturer: Duperon Corporation

Number of units: 2 North Channels

- 1) Screen No. 1 SCN-SG721
- 2) Screen No. 2 SCN-SG722

1 South Channel

- 3) Screen No. 3 SCN-SG723

Equipment designation: FPFS

Equipment location: City of Ann Arbor WWTP (Indoors), MI.

2. The equipment shall be manufactured by Duperon Corporation, 1200 Leon Scott Court, Saginaw, Michigan, 48601, (800) 383-8479, in accordance with this section
3. All equipment supplied under this section shall be furnished by a single Screening System Supplier who shall coordinate with the Contractor, the design, fabrication, delivery, installation and testing of the screening components. The Screening System Supplier shall have the sole responsibility for the coordination and performance of all components of the screenings system with the performance and design criteria specified herein.
4. The Contractor shall be responsible to coordinate all details of the screening equipment with other related parts of the Work, including verification that all structures, piping, wiring, and equipment components are compatible. The Contractor shall be responsible for all structural and other alterations in the Work required to accommodate the equipment differing in dimensions or other characteristics from that contemplated in the Contract Drawings or Specifications.

B. Washer / Compactor

1. Scope of Work

- a. Duperon Corporation shall furnish an interleaving, dual auger washer compactor assembly as shown on the drawings and as specified herein. A single unit shall provide washing and compacting action on wastewater screenings. The equipment shall be manufactured by Duperon Corporation,

1200 Leon Scott Court, Saginaw, Michigan, 48601, (800) 383-8479, in accordance with this section.

1.2 RELATED SECTIONS

- A. The following list of related sections is provided for the convenience of the Contractor and is for reference only to support commonly referenced sections that are in-general applicable to all equipment supplied. (For complete list of sections see specification index.)
- B. All sections of Division 1 including but not limited to Submittal Procedures, Shop Drawings, Product Data and Samples, Operating and maintenance information, Protection of Materials and Equipment, Installation, Testing, and Commissioning, Instruction of Operations and Maintenance Personnel, and Spare Parts Maintenance Manuals.
 - 1. Section 05051-Anchorage
 - 2. Section 09900-Coating Systems
 - 3. Section 15000-General Requirements for Equipment
 - 4. Section 17500-Enclosures General

1.3 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI)
- B. American Society for Testing and Materials (ASTM)
- C. American Welding Society (AWS)
- D. American Institute of Steel Construction (AISC)
- E. American Bearing Manufacturers Association (ABMA)
- F. American Gear Manufacturers Association (AGMA)
- G. National Electrical Manufacturers Association (NEMA)
- H. Underwriters Laboratory (UL)

1.4 SUBMITTALS

- A. The equipment manufacturer shall submit the following items:
 - 1. General Arrangement drawings that illustrate the layout of the equipment, equipment weight, principal dimensions with related verifications required for installation including anchorage locations. Other related data including descriptive literature, Electrical Control Drawings, Catalog Cut Sheets for individual components and Drive Motor Data.
 - 2. A list of recommended Spare Parts including any Special Tools required for routine maintenance of the equipment is provided in Section 2.5.
 - 3. O & M Manuals including As-Built Drawings of the Mechanically Cleaned Bar Screen Arrangement, Controls and Accessories shall be provided in digital format after equipment ship for inclusion in the Close-Out Submittal process. Provide 3 binders of approved and final O&M manuals and digital copy.

4. For sites that have (3) ft or greater head differential, equipment manufacturer shall provide Structural Certification from licensed Civil engineer

1.5 QUALITY ASSURANCE

- A. All equipment supplied under this section shall be of a single manufacturer and demonstrate, to the satisfaction of the Engineer, that the quality is equal to equipment made by those manufacturers specifically named herein.
- B. The Mechanically Cleaned Bar Screens shall be fully assembled and shop tested at the manufacturing facility prior to shipment. Shop testing shall include a minimum of 4 hours of run time. Perform the tests with the project control, including full automatic modes of operation. The contractor, the engineer, the owner or the owner's designated representative reserves the right to witness the shop test. A minimum three (3) week notice shall be provided prior to the test to allow for travel coordination.
- C. To assure quality and performance: All equipment furnished under this Section and related sections shall be of a single manufacturer who has been regularly engaged in the design and manufacture of the equipment and demonstrates, to the satisfaction of the Engineer, that the quality is equal to equipment made by those manufacturers specifically named herein. And the screen manufacturer shall have at least 50 installations of the specified link driven model of mechanically cleaned bar screen equipment that has been in successful operation, at similar installations, for at least ten (10) years. Upon request, the manufacturer shall provide a reference of such installation sites along with the relevant contact information.

Possible consideration may be given to manufacturers with less installation experience but only upon submission and approval of dimensional and installation drawings and O & M Manuals. Additionally, a complete product development plan with dates indicating all applicable alpha and beta testing shall be provided for review and acceptance.

Approval of any manufacturer that does not meet the installation experienced defined herein shall be contingent upon submission and approval of the previously defined information. Additionally, such manufacturers shall be required to provide a performance bond issued in favor of the owner, covering the full amount of the manufacturer's offering and for the entire warranty period of the project.

- D. The equipment furnished shall be fabricated, assembled, installed and placed in proper operation condition in full conformity with approved drawings, specifications, engineering data, and/or recommendations furnished by the equipment manufacturer.

1.6 WARRANTY

- A. Manufacturer shall provide a written two-year standard warranty from the date of use of the Mechanically Cleaned Bar Screen Equipment and Washer Compactor Equipment to guarantee that there shall be no defects in material or workmanship in any item supplied.
- B. Manufacturer shall warrant for the period of 5 years all rotating parts of the Mechanically Cleaned Bar Screen including the gear motor, bearing, drive head, and the link system including the links, castings, pins and retaining rings. Manufacturer warrants that these components shall be replaced if damaged or defective in the normal use of the equipment.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Screens and Washer Compactors shall be as manufactured by Duperon Corporation, 1200 Leon Scott Court, Saginaw, Michigan, TF 800.383.8479. The screens shall be the FlexRake® Model, Full Penetration Fine Screens.

2.2 SCREENS

A. BASIS OF DESIGN

1. The mechanically cleaned bar screen shall have a head sprocket only, with no sprockets, bearings, idlers, or similar drive components under water to trap the chain. Equipment featuring reciprocating rake arms or lower bearings/sprockets/tracks below the water is not acceptable.
2. The mechanically cleaned bar screen shall meet the total screen debris removal capacity of:

Scraper Ratio below Water Level:

Upstream Water Level (ft) / 1.745 ft = Number of Scrapers below Water level

Debris Volume per Linear Foot = 0.152 ft³/hr (0.046 m³/m)

Total Screen Debris Removal Capacity on Low (ft³/hr) =
(0.152 ft³/ft) x (Screen Width) x 60 x (Number of Scrapers below Water Level)

Total Screen Debris Removal Capacity on High (ft³/hr) =
(0.152 ft³/ft) x (Screen Width) x 260 x (Number of Scrapers below Water Level)

3. The flow ability of the screen area, specifically, shall be defined as follows: A composite number representing the specific flow- ability of a screen area composed of the bars' Hydraulic Headloss

$$\text{(Coefficient Shape Factor)} \times \left(\frac{\text{Bar Width}}{\text{Clear Opening}} \right) = \left(\frac{0.190}{\text{Clear Opening}} \right)$$

4. The mechanically cleaned bar screen shall be designed to run continuously (24/7), without operator.
5. The equipment shall have multiple scrapers on the bar screen at one time cleaning continuously from bottom to top, the entire width of the bar screen. The drive output shaft rotation shall be constant and in one direction in order to reduce maintenance and increase product life. Units which have single raking arms or that require cycle times shall not be allowed. Cleaning mechanisms that utilize shock absorbers, springs or other dampening or hydraulic actuations are unacceptable.
6. The link system shall have jam evasion capability by flexing around and collecting large objects such as a 2 X 4, bowling ball, grease balls and surges of solids at peak loading times without overloading and shutting down the unit. The link system shall

be such that it bends in one direction only which allows it to become its own lower sprocket and frame and shall have a 1,000 pound lifting capacity.

7. Designs employing the use of endless moving media or cables and hydraulic cylinders to remove debris from the channel and units utilizing proximity or limit switches for reverse cycles are not acceptable.
8. Equipment utilizing a greater than ½ HP motor or two or more motors to complete a screen cleaning cycle is not acceptable.
9. The design shall be such to ensure that all maintenance can be accomplished at the operating floor level or above. No part of the drive system including sprockets shall be located below the water surface at maximum design flow.

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10. Design Conditions:

North Channels Installation Information:	
North Channel Width:	4.5 ft
North Channel Height:	8 ft
(upstream clearance) Channel Depth:	9 ft
Bar Opening Size:	1/4"
Angle of Installation:	10 deg from vertical
Average Flow (per channel):	6.3 MGD (ADF)
Average Water Level:	3.25 ft
Maximum Flow:	30 MGD per channel
Maximum Water Level:	7 ft
Maximum Head Differential:	1 ft
Equipment Location:	Indoors
South Channel Installation Information:	
South Channel Width:	10 ft
South Channel Height:	6 ft 6 in
(upstream clearance) Channel Depth:	5 ft 11 in
Bar Opening Size:	1/4"
Angle of Installation:	10 deg from vertical
Average Flow:	6.3 MGD (ADF)
Average Water Level:	2.75 ft
Maximum Flow:	30 MGD
Maximum Water Level:	2.75 ft downstream
Maximum Head Differential:	1 ft
Equipment Location:	Indoors
Indoor Installation:	
Ceiling Height (From Operating Floor):	17 ft (North) & 12 ft 8 in (South)
Site Access Constraints:	Existing Roof Hatches
Roof Opening Available:	Yes
Roof Hatch Size (North):	5 ft 3 in x 15 ft 5 in
Roof Hatch Size (South):	6 ft x 11 ft
Other Site Constraints:	N/A
Installation Area Classification:	Class I Div I
Below Freezing Temperatures:	No – onsite HVAC
Collection and Conveyance:	
North Channel Debris Bin Dimensions:	8 ft x 12 ft
South Channel Debris Bin Dimensions:	8 ft x 12 ft
Sluice:	North Channels Y Sluice by Duperon South Channel Sluice by Duperon
Washer/Compactor:	Yes, Dual Auger Design

B. COMPONENTS

1. Bar screen assembly: Bar screen assembly shall be of stainless steel and designed to withstand 1 foot head differential unless noted otherwise in Section 2.2. Design Conditions. Unless noted otherwise materials of construction shall be 304 Stainless Steel. A stainless steel channel bottom plate shall be an integral part of the bar screen assembly to fully engage scrapers in the bar screen at the base of the unit and assure that the raking mechanism reaches the bottom of the screen to prevent debris accumulation. The Bar screen assembly shall be shipped in one piece.
 - a. Screen Bars: Bars shall be 316L stainless steel and be tear-shaped with a Hydraulic Coefficient shape factor of 0.76 and the minimum dimensions of 0.25 inch x 0.75 inch x 0.13 inch. Bars shall be individually replaceable without welding.

- b. Side Fabrication: The screen framework shall be 304 stainless steel bent plate with minimum of 3/16 inch cross section.. Horizontal members shall be of stainless steel bent plate or stainless steel pipe. Support members and frame shall adequately support the bar screen based on site specific requirements.
 - c. Dead Plate: Dead plate shall be 0.25 inch thick 304 stainless steel. The dead plate shall be flat and true; span the entire width of the unit; and transition from bar screen to discharge point.
 - d. Discharge Chute: The discharge chute shall be 11ga. (0.12 inch) 304 stainless steel. The discharge chute shall be bolted to the dead plate and shall be designed to allow debris to be transferred from discharge point into the debris containment.
 - e. Link Slides: Link slide assembly shall be provided per manufacturer standard design and shall be constructed of UV Stable UHMW PE rollers and 304 stainless steel supports and components.
 2. Return Guide/Closeouts: Return guide/Closeouts shall be 304 stainless steel and shall assure proper alignment of scrapers as they enter the bar screen and assure that there is no space wider than the clear opening between bars to prevent passage of larger solids than allowed through the screen.
 3. Debris Blade: A 304 stainless steel and UV Stable UHMW-PE debris blade assembly, which does not require a separate drive, shall be installed to assist in removing debris from the scraper on the mechanically cleaned bar screen unit as recommended by the manufacturer. Hydraulic, shock, or spring controlled debris blade mechanisms are not acceptable.
 4. Screen Enclosure: A 14ga. #4 brushed satin finish 304 SSTL Enclosure shall be installed to cover the screen above the operating deck level. Front Enclosure shall have removable panels for access to equipment. Removable panels shall be 16ga. 304 SSTL and shall be provided with knurled knobs for "no tool required" access. Alignment notches shall be included to support repositioning of removable panels. The top of the Front enclosure shall include a knock out for a customer site option to install a 6-inch diameter pipe stub. (The option of connecting to the site's exhaust system, to provide a positive air exchange from interior of enclosure, by Others.) Rear Enclosure shall have hinged removable doors and shall be secured with a lift-slide-latch handle. Rear removable door shall include an integral viewing door that shall be secured with a lift-slide-latch handle to provide access for a quick look inside.

For multi-deck applications, 14ga. #4 brushed satin finish 304 SSTL side shields will also be provided.

 - a. Front Enclosure Design Options:
 - 1) SSTL removable panels (standard)
 5. Link System: The link system shall be passivated stainless steel castings and have a minimum ultimate strength of 60,000 lbs with a minimum cross section of 1.5 inches and weighing a minimum of 4.5 lbs each. Parts must meet ASTM A380 specification for surface finish.
 - a. 304 stainless steel system includes 302 stainless steel retaining rings and 304 stainless steel pins.

6. Scrapers: Scrapers shall be spaced 21 inches apart. To provide long product life the scraper shall move at no greater than 28 inches per minute at standard operating speed of 1/2 rpm allowing for approximately 1 debris discharge per minute. Staging Scrapers and Thru Bar Scrapers shall be a maximum ratio of 1:1 per manufacturer recommendations. At least one scraper every 84 inches shall fully penetrate the bar screen, cleaning all three sides of the bars as well as through to the cross members in openings of 0.25, 0.375 and 0.50 inches.
 - a. Staging Scrapers; Staging Scrapers shall be 1 inch thick x 4 inches x screen width UV Stable UHMW-PE with a serrated edge.
 - b. Thru Bar Scrapers: Thru Bar Scrapers shall be minimum .375 inch thick x 5 inches x screen width 304 stainless steel.

7. Drive Head: The Drive Head shall be located at the top of the mechanically cleaned bar screen.
 - a. Drive Unit: Each mechanically cleaned bar screen unit shall operate independently and shall have its own drive unit and driven components.
 - 1) Drive Sprockets and end castings shall be cast 304 stainless steel.
 - 2) Drive Shaft shall be 304 stainless steel.
 - 3) Gearbox shall be shaft-mounted, right angle type and include spiral bevel gearing. The output shaft speed shall be controlled by a vector type inverter or per rake manufacturer's recommendation. It shall have at least a 1.52 or greater service factor based on machine torque requirements. The gearbox shall not be vented to the outside atmosphere. The gearbox shall be grease filled. Oil filled gearboxes are not allowed.
 - 4) The motor shall be AC induction type, inverter duty, 3 phase 240/480 volt and mounted to the gear reducer. The motor shall be 1/2 hp, designed for 1800 RPMs base speed and rated for Class I, Groups C & D, Class II Groups F & G environments. The motor shall have an EPNV enclosure, NEMA design B with a 56C frame size. Service factor shall be 1.0 or greater, Class F insulation and be optimized for IGBT type inverters. The motor must be UL listed and designed for continuous operation.
 - 5) Motor shall have built in, normally closed, thermostat to protect from overheating that is to be field wired to corresponding terminal in control panel for redundant (ambient) overload protection.
 - 6) All drive head components shall be of components available in the United States.
 - b. Bearing: Bearing shall be greased Timken tapered roller bearings, non self-aligning, dual lip sealed, lubricated, and shall have a 24/7/365 L10 life of 20 years when in compliance with stated O&M recommendations.
 - c. Speed Reducer: Speed reducer shall be a double-reduction, cycloidal style and shall comply with all applicable AGMA standards. The speed reducer shall be capable of a 4/1 speed range with variable output speeds between 0.50 to 2.2 output RPMs (in high flow conditions). The speed reducer shall produce an output torque of 11,417 in.lb. and have a gear ratio of 809:1.

8. Standard Coating: All non-stainless bar screen components shall be coated in strict accordance with the paint manufacturer's specification. Surface Preparation shall be done in accordance with SSPC-SP-10 Near White. The three-part coating system

shall be manufactured by Tnemec as follows: Prime Coat Series 90-97 Theme Zinc at 2.5-3.5 mils DFT, Intermediate Coat Series 27 F.C. Typoxy at 3.0-5.0 mils DFT, and Top Coat Series 1095 Endura-Shield at 2.0-3.0 mils DFT. Standard color is 11SF Safety Blue. Material shall meet all state and federal VOC and other regulatory requirements.

Alternatives: Any alternate products must provide certified test reports when submitting products other than those specified herein the specification. Test reports shall indicate the test method, system and requirements for those products being submitted, and shall meet or exceed the test criteria and performance values of the specified coatings herein.

C. ELECTRICAL, CONTROLS, INSTRUMENTATION

1. General: Controls for each rake shall be in enclosures provided by the bar screen manufacturer. The bar screen manufacturer shall be responsible for proper sizing and function of the controls at 480V, unless specified otherwise.
 - a. Controls shall be designed to accept incoming power supply per contract documents and shall include a step-down transformer as needed to achieve 120V.
 - b. Control Panels shall be constructed to meet the appropriate NEMA 4X classification requirements and will include a main, lockable disconnect. The panel will be constructed by a UL certified control panel build facility and will be supported by the appropriate UL labeling.
 - c. Controls shall be tested prior to shipment to owner. The rake manufacturer shall verify all overload settings in the rake controller to ensure proper overload and speed settings required for the application are properly programmed.
 - d. Control panels shall be wired complete with a minimum of #16 MTW wire in the appropriate colors for the circuits being supplied. 120VAC control shall be red, grounded AC neutral shall be white, DC control shall be blue, DC neutral shall be blue with a white tracer, equipment ground shall be green and all incoming and outgoing external power source wires shall be a yellow configuration. All AC power wiring shall be a minimum of #12 Black. All wires shall be labeled at both ends with heat-shrink wire markers. Internal panel wiring shall be contained in non-flammable, covered wire way.
 - e. All panels and panel mounted devices shall be labeled with engraved I.D. markers that reference back to the system schematics. Tags shall be white with black core, engraved as required. Refer to section 17000.
 - f. All field wiring and power cables between the bar screen Screen/Compactor Control Panel (SCN-CP-SG72*) and the Local Push Button Station shall be provided by others under the Electrical Section. VFD rated motor cable (Belden #29502 or equal) is recommended for all motors. Motor cables shall be less than 80 ft unless otherwise specified.
2. Components:
 - a. Screen/Compactor Control Panels (SCN-CP-SG721, SCN-CP-SG722, SCN-CP-SG723).
 - b. Screen/Compactor Control Panels shall be NEMA 4X 304 SSSL for indoor installations.
 - c. Enclosure shall not be in an explosive environment.

- d. Screen/Compactor Control Panels shall be designed with a SCCR rating of 18KA at 480VAC minimum and labeled as such, unless otherwise specified.
 - e. All terminals utilized in the main panel shall be 600V rated terminals and 20% spare terminal space shall be provided for any potential future revisions.
 - f. The Screen/Compactor Control Panels shall include at a minimum the following:
 - 1) Main fusible disconnect with lockable operator, unless otherwise specified.
 - 2) Uninterruptible Power Supply.
 - 3) Physical Hand/Off/Auto (HOA) Selector switch and Push/pull E-Stop button.
 - 4) Elapsed run-time meter
 - 5) Indicating lights for "Power On", "Forward".
 - 6) Alarm lights for recommended fault conditions.
 - g. Screen and compactor controls shall be Programmable Logic Controller (PLC) based and include but not limited to the following:
 - 1) Allen Bradley Micrologix 1400 PLC.
 - 2) Allen Bradley operator interface terminal (OIT), 10" PanelView Plus 7. The OIT shall display the process and equipment using graphical representation of the screen system.
 - 3) Ethernet Switch for interface with OIT and existing plant PLC.
 - 4) Variable Frequency Drive (VFD).
 - 5) OIT programmable functions accessible to the operator for adjustment of timers and setpoints.
 - 6) SCADA monitoring and control via Ethernet Communications Protocol.
3. Local Control Station (LCS)
- a. Enclosures shall be NEMA 7 rated for Classified area installation. Local push button station must be local to the equipment to maintain requirements of local safety codes as determined by the Engineer.
 - b. Local station shall be mounted within 10 feet or as close to the equipment as safely possible and be field wired by the electrical subcontractor to the corresponding terminal inputs in the main control panel. Refer to electrical drawings for location and quantity. Field locate per Owner / Engineer's direction.
 - c. The remote pushbutton stations shall include a Hand Off Auto selector switch and E-Stop buttons for each screen and compactor.
4. Instrumentation: Each raking assembly shall have a separate level system that shall be installed, and field wired by others per the manufacturer's instructions.
- a. Each bar screen shall be provided with a dual transducer ultrasonic level transmitter. Transmitters shall be wall mounted near the screen/compactor control panels. Siemens HydroRanger 200 with two ultrasonic level transducers or equal manufactured by Vega. Transducers shall be installed upstream and downstream of the rake, at least 1 foot above the highest anticipated water elevation and the beam angle shall not have obstructions between the transducer face and the water surface. Refer to installation details and Section 17740 for additional requirements.

- b. Differential Level Control: Both analog signals, upstream and downstream of the screen shall be connected to the screen/compactor PLC. The PLC program shall include differential setpoints used to automatically start/stop the rake based on the headloss across the screen. The logic shall also include a "Rake Off" setpoint which shall be lower than the initial run setpoint. This setpoint is required to help avoid intermittent starting/stopping caused by the differential level equalizing with minimal rake run time. Cycle timing logic shall also be included in the program that shall function in parallel with the differential level control logic for optimal rake run time.
 - c. Contractor shall coordinate with manufacturer and instrumentation and controls subcontractor for addressing and tagging.
 - d. All accessories and appurtenances required for a complete and operational system shall be provided.
5. Control Operations -
- a. Each screen shall be configured to operate in the manual or automatic mode as follows.
 - b. When the screen local control station (LCS) HOA switch is in the HAND position the screen shall run continuously. When the HOA is in the OFF position the screen shall not run on any condition. When the HOA switch is in the AUTO position the screen shall run based on the PLC in the control panel as described below.
 - c. The operator shall be able to select three control modes. Timer mode, combined mode, or level mode. When the timer mode is selected, the screen shall operate based on the preset timer parameters (adjustable). When the level mode is selected, the screen shall operate based on the pre-set level differential setpoints (adjustable) and combined as described below.
 - d. Under normal conditions, the screen shall be operated in the COMBINED mode controlled by an adjustable on/off PLC cycle timer on a timed basis. The timed operation of the screen will be overridden by a high differential level condition as follows:
 - 1) When the differential level reaches a predetermined set point, the screen shall begin operation in low (normal) speed and shall shut down after a predetermined time if the differential level has dropped below the predetermined set point.
 - 2) If the differential level increases to a second, higher predetermined set point, the screen shall operate in high speed and shall either shut down after a predetermined time if the differential level is less than the low differential level set point or slow to low speed if the differential level is below the high differential level setpoint but above the low differential level setpoint.
 - 3) When the E-STOP at the LCS is engaged, the screen shall stop all functions immediately.
 - e. When running in continuous mode:
 - 1) The screen runs at normal speed until a high upstream level (adjustable of initially set at 8 ft.) is reached.
 - 2) Upon high level, the screen runs in high speed for 5 minutes (set in PLC program), and if the level drops to (adjustable of initially set at 7 ft.) is reached the speed resumes slow speed.
 - f. When running on timer mode:

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- 1) The screen runs at normal speed for a predetermined time duration initially set at 2 minutes (adjustable) and stops and stays off for a predetermined time initially set at 2 minutes (adjustable).
 - g. When running on differential head or high upstream head.
 - 1) The screen starts on high head and runs at normal speed for a predetermined time of 5 minutes (adjustable).
 - 2) If the upstream water level drops below 7 ft. (adjustable), the screen stops. Otherwise, the screen continues to run at normal speed for an additional predetermined time of 5 minutes (adjustable).
 - h. Washer Compactor Control
 - 1) Once a screen is commanded to run, the corresponding screenings washer compactor is also commanded to run. The washer compactor runs continuously until the screen is commanded to stop, at which point the compactor continues to run to < 2 > minutes then shuts off.
 - i. Alarms/Interlocks
 - 1) Alarms are established per manufacturer recommendations.
 - j. Upon screen failure alarm, the compactor continues to run for predetermined time of 5 minutes (adjustable), then shuts off.
 - 1) Upon washer compactor failure alarm, the screen continues to operate.
6. Controls Design Conditions:

Incoming Power: (Voltage/Phase)	480/3/60
Enclosures:	1 Main Panel for North Channels 1 Main Panel for the South Channel
Installation location:	Indoors
Approx. distance between main panel and equipment motor	TBD – Submittal Phase
Climate controlled location:	Yes
Transducer/Float cable length (50 ft standard):	Provided length if longer than 50 ft

D. SPECIALTY TOOLS, SPARE PARTS AND LUBRICATION

- 1. Manufacturer shall provide any specialty tools and recommend spare parts required for maintaining the equipment as follows:
 - a. Drive Clevis Pin (1)
 - b. Snap/Retaining Rings (10)
 - c. Link Clevis Pins (4)
 - d. Scraper Bolts (4)
 - e. Scraper Nuts (4)
 - f. Snap Ring Tool (1)
 - g. Never Seez, 1 oz. tube (1)
- 2. Manufacturer shall provide one tube of Multi-Purpose grease which is a 5-year supply of lubrication, required for maintaining all bar screen components.

2.3 SCREENING TRANSFER SLUICE

- A. Performance and Operation Requirements:

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1. The screening conveyance equipment shall be provided by the same manufacture that provides the bar screening and the washer compactor equipment.
 2. Sluice Trough system must be capable of receiving and conveying raw sewage screenings from multiple bar screens with a combined site flow rate of 60 MGD and convey the screenings to a washer compactor up to 25 feet away using plant effluent/utility water.
 3. Screening removal system shall be capable of both manual and automatic operations.
 4. Plant water demand required by the screens, sluice and washer compactor shall-not exceed more than a single header pipe of 1-1/2" dia. delivers at 60 psi.
 5. Spray wash and conveying water for both sluice and Washer Compactor working parameters to be within the supply water flow of 60 GPM
 6. Trough wash water system shall be designed by the Manufacturer so that no screening debris hang-up occurs, and 100% of the screenings are flushed to the washer compactor. If this is not achieved, provide a second spray bar with multiple nozzles along with a globe valve for throttling flow and a ball valves for on-off manual control.
 7. Sluice trough enclosure components must be water tight along entire lengths and incorporate provisions for odor control piping connections and auxiliary spraying connections throughout the systems configuration as specified and indicated within the contract drawings.
- B. Load Criteria
1. The screening troughs must be designed to carry water up to the top of trough that contains rags, plastic, grit, stone, grease, fecal matter and other debris associated with raw sewage system.
- C. Design and Construction
1. All materials of construction must be suitable for the environment conditions for operation with corrosive and abrasive wastewater screenings and corrosive gases associated with raw sewage.
 2. Sluice conveying surfaces must smooth and have no projecting fasteners, protrusions or leading edges that would potentially snag, block or accumulate any debris material.
 3. Layout configuration must be free standing and components must bolt together in a leak free manner while allow individual leveling adjustments of +/- 0.75" per 10 linear feet.
 4. Sluice component sections must be of modular design and accommodate both straight Y Shaped and curved sections for flexible layout configurations.
- D. Basis of Design
1. U-Shape Profile: 9" Radius bottom/ 6" vertical walls, 2" horizontal upper flanges
 2. Straight Section: U-shape trough profile with bolt flange ends for component connection
 - a. 4 foot max unsupported
 - b. 8-10 feet between leg set
 - c. Max length of 16 feet per section
 - d. Inlet plate supplied on one end of straight section with (3)-welded 1" NPT threaded couplings at 3/6/9 o'clock position for multiple water connection points.
 3. Elbow "Corner" Section: U-Shape trough profile with bolt flange ends for component connection

- a. 36" centerline radius of sections. (90° section: Overall footprint size 4 sq. feet)
 - b. 30, 45, 60 & 90 degree sections available
 - c. Y-Shaped merge section required per Layout along with manually activated diverter plates to transfer debris to one or both washer compactors per the site layout plans.
4. Top Cover section: Goes on top of U-Shape Profile to help contain debris and odor control
- a. Hinged and removable cover sections available in 4 foot lengths
 - b. Customized vents in top for odor control ventilation duct work per site specifications.
5. H-Support LEG Set: Stainless steel welded construction
- a. ¼" bottom base plate with (4) - holes near corners for 1/2" lag/anchor bolts.
 - b. (2)-vertical ¼" x 2"x 2" angles with (2)-clearance holes per side for trough base plate mounting.
 - c. (1)-horizontal ¼" x 2"x 2" angle for jack bolt leveling of Sluice.

2.4 WASHER COMPACTOR UNITS

A. Basis of Design

1. Compacting Action: The Washer Compactor shall have dual augers to provide positive displacement action. Augers shall be oriented on top of each other and rotate in opposing directions. Augers shall be intermeshed, with one left-hand and one right-hand lead. Augers shall be designed with a limited float on top of a strainer to allow for the accommodation of irregular debris.
2. Washing Action: The Washer Compactor shall have a wash water manifold integrated into the main housing. Two ports inside the unit shall emit a medium pressure stream. Wash water shall run continuously when the Washer Compactor is in motion. Continuous operation (non-batching) equipment is required; filling- and batching-type equipment shall not be accepted.
3. Operation: The Washer Compactor shall be continuous run, not requiring an operator. The Washer Compactor shall be equipped with a self-regulating, active pressure zone designed to accept non-standard wastewater debris in its original form, including but not limited to: rocks; broken concrete; and metal (such as bolts or short pipe) up to 4 inches long. The Washer Compactor shall have the ability to process multiple pieces of clothing, variable volumes of debris, and unprocessed septage or grease. The Washer Compactor shall move at a normal operating speed of 2.4 to 9.8 RPM and shall have the ability to run intermittently to sync with upstream equipment.
4. Materials:
 - a. Fabrications: All welded fabrications shall be made from stainless steel. All welded connections and welding procedures shall comply with AWS "Structural Welding Code – Sheet Steel" D1.3/D1.6.
 - b. Select Parts: Select power transmission parts to be made from cast iron; however, shall conform to standard coating as follows.
 - c. Standard Coating:
 - 1) Motor gearbox shall be coated in strict accordance with the paint manufacturer's specification. Surface preparation shall be done in

accordance with SSPC-SP-10 near White. The three-part coating system shall be manufactured by Tnemec as follows: Prime Coat Series 90-97 Tnemec Zinc at 2.5-3.5 mils DFT; Intermediate Coat Series Typoxy at 3.0-5.0 mils DFT; and Top Coat Series 1075U Endura-Shield II at 2.0-3.0 mils DFT. Standard color is 11SF Safety Blue. Material shall meet all State and Federal VOC and other regulatory requirements.

- 2) Alternatives: Any alternate product must provide certified test reports when submitting products other than those specified herein. Test reports shall indicate the test method, system, and requirements for those products being submitted and shall meet or exceed the test criteria and performance values of the coatings specified herein.
- d. Non-Metal: Parts not covered in the specifications above shall be manufactured from UHMW polyethylene.

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5. Design Conditions:

Washer Compactor WC3.B2.5 Data Sheet	
Peak Capacity:	90 cu.ft./hr (5 minutes)
Average Capacity (Continuous):	25 cu.ft./hr
Wastewater Application (1/4" barscreen):	Up to 60 MGD
Water: Typical	<ul style="list-style-type: none"> Utilizes filtered effluent or municipal water Consumes 3-10 GPM Requires 40-60 PSI 1/2 inch NPT supply (female threads) 4 inch NPT drain (male threads)
Materials of Construction:	<ul style="list-style-type: none"> 304 SSSL 17-4 Spur Gears Delrin (or equivalent) thrust and plane bearings UHMW Auger Supports
Strainer:	<ul style="list-style-type: none"> Wedgewire Screen
Hopper Height (Deck to Hopper):	38"
Hopper Length (WC3.B2.X Unit):	43"
Below Freezing Temperatures:	N/A – Onsite HVAC
Performance Data (Typical Wastewater Debris)	
Dry Solids:	30%-60%
Mass/Weight Reduction:	60%-70%
Volume Reduction:	70%-80%
Odor/Fecal:	Significantly decreases odor/fecal
Motor/Drive	
Motor Size:	3 HP
Motor Paint:	Duperon® Standard Tnemec Coating
Motor Service Factor (Minimum):	1.0
Output Speed:	9.8 RPM
Speed Reducer Ratio/Output:	179:1
Speed Reducer Paint:	Duperon® Standard Tnemec Coating
Site Power	
Phase/Voltage:	240/480 volt
Controls	
	<ul style="list-style-type: none"> Integrated into Main Panel for Bar Screens Main Disconnect Emergency Stop HOA (Auto is discreet "Run" input) Fwd/Jog Reverse/E-Stop Push Button Station "Run" and "In Auto" discrete outputs Explosion-Proof station (local standard)
Mounting:	<ul style="list-style-type: none"> Wall Pedestal (by others)
Project Management	
Submittal Quantity:	2 – 4
O&M Manual Quantity:	2 – 4
Warranty Period:	2 year
Shipping	
	<ul style="list-style-type: none"> Main unit Chutes

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B. Components

1. Main Housing: The main housing of the Washer Compactor shall be constructed of stainless steel (material options contained in table) with a minimum thickness of 11 gauge. Support and flange connections shall be 3/8 inch.
2. Hopper: The hopper of the Washer Compactor shall be constructed of stainless steel (material options contained in table) with a minimum thickness of 11 gauge. Hopper will have a 6" Dia overflow drain (to be plumbed by contractor).
3. Augers: The augers shall be of stainless steel (material options contained in table) with 8 inch diameter flights, 3/8 inch thick, with 4 inch flight pitch. The augers shall be coupled to a transmission at the drive end and be supported at the compaction end with UHMW plane bearings. This arrangement shall allow for the accommodation of irregular debris. The auger shaft shall be 2 inch stainless steel schedule 40 pipe with 2 inch solid stainless steel stub shaft.
4. Compaction Housing: The compaction housing of the Washer Compactor shall be 1/4 inch stainless steel (material options contained in table) and shall house a spring and gate assembly to provide the resistance for compaction. The compaction housing shall contain the auger supports.
5. Discharge Chute: The discharge chute of the Washer Compactor shall be constructed of stainless steel (material options contained in table) with a minimum thickness of 14 gauge. Support and flange connections shall be 1/4 inch. The discharge chute shall be tapered outward toward the discharge end.
6. Water Supply: The water supply shall connect at a single point with a 1/2 inch NPT female connector. A NEMA 7/9 Explosion proof solenoid valve is provided to limit the wash water flow to only when the washer compactor is running. Globe and ball valves shall be provided to control and distribute flow to the washing and trough sprayer connections.
7. Strainer: A strainer shall be located beneath the lower auger to filter the washed solids. The strainer shall be removable via drain trough and pressed against the lower auger with spring pressure. The strainer shall be self-cleaning through continuous, even contact with the lower auger. Strainers requiring auger-mounted brushes will not be accepted.
8. Drain Trough: A removable pan shall be provided beneath the main housing to collect wash water. Wash water shall be drained through a 4 inch NPT male drain port. The pan shall be a minimum of 11 gauge stainless steel (material options contained in table).
9. Drive Assembly:
 - a. Each Washer Compactor unit shall operate independently, with its own drive unit and driven components. The gearbox shall not be vented to the outside atmosphere.
 - b. The gearbox shall be grease lubricated and designed for 5 years (or 20,000 hours of operation) between recommended clean and re-grease services. The gearbox shall be right angle type, and shall incorporate cycloidal and spiral

bevel gearing with a total ratio of 179:1. The gear reducer output shaft speed shall be 2.4 RPM minimum to 9.8 RPM maximum and controlled by an AC Tech, vector-type inverter (or greater service factor) based on unit torque requirements. It shall be shaft-mounted utilizing the keyless Taper-Grip® bushing.

- c. The motor shall be mounted to the gear reducer by utilizing a quill, C-Face mounting style. The motor shall be AC induction type, 3 HP, 3/60/230/460 volt, explosion-proof, inverter-duty model.
- d. The drive assembly shall incorporate the Duperon® standard coating system.

10. Auger Transmission:

- a. The Drive Assembly shall be coupled to a dual gear transmission, which drives the augers in a counter-rotation.
- b. The spur gears are contained in a stainless steel housing and supported by Delrin (or equivalent) plane bearing.
- c. Grease fittings shall be located outside of the transmission housing to provide lubrication to the gears.

11. Speed Reducer: The Speed Reducer shall have a maximum output of 9.8 RPM, 179:1 reduction ratio with 18,900 in-lb. of output torque.

12. Thrust Bearings: Thrust Bearings shall be Delrin (or equivalent), self-lubricating, and be capable of withstanding a minimum of 2000 lb. of thrust load (each auger) at 9.8 RPM for life of machine.

13. Screw Supports: Screw supports shall be UHWM plane type, self-lubricating, and fastened into place using stainless steel fasteners.

C. ELECTRICAL, CONTROLS, INSTRUMENTATION

1. General: Controls for the washer compactor shall be included in the Screen/Compactor panel. The washer compactor manufacturer shall be responsible for proper sizing and function of the controls at 480V, unless specified otherwise.

- a. Controls shall be designed to accept incoming power supply per plans/specs and shall include a step-down transformer as needed to achieve 120V.
- b. Controls shall be tested prior to shipment to owner. The washer compactor manufacturer shall verify all overload settings in the motor controller to ensure proper overload and speed settings required for the application are properly programmed.
- c. Sequence of Operations:
 - 1) The Washer Compactor controls shall enable the push button station installed near the Washer Compactor when in “Hand” mode and utilize an input signal from a remote source when in “Auto” mode. Upon receiving a disruption of “remote source” signal in “Auto” mode, the Washer Compactor shall utilize an off-delay timer to allow debris to finish depositing. The washwater solenoid is energized any time that the washer compactor is running.
 - 2) The Duperon® Speed Controller fault shall be cleared by turning off the Washer Compactor, then waiting approximately three minutes (or time designated per current UL standards) and then turning the HOA

back to the desired setting. A motor overtemperature fault shall clear automatically when the motor cools to a temperature within the normal operating range.

- d. Miscellaneous:
 - 1) The following shall be provided by the electrical contractor and are not part of the Washer Compactor manufacturer scope of supply:
 - a) Mounting stands
 - b) Mounting hardware
 - c) Field wiring and conduit
 - (1) VFD-rated motor cable (Belden #29502 or equal) recommended for all motors.
 - (2) Motor cables shall be less than 80 ft. long unless specified otherwise.
 - d) Junction boxes
 - e) Installation
 - 2) Field wiring shall include (but not be limited to) the following connections as applicable:
 - a) All incoming power supply to the main control panel.
 - b) All required grounding of the motor and controls.
 - c) Motor to the main control panel.
 - d) VFD-rated motor cable (Belden #29502 or equal) recommended for all motors.
 - e) Motor cables shall be 80 ft. long unless specified otherwise.
 - f) Motor thermostat to the terminal inputs in the control panel.
 - g) Washwater solenoid wiring
 - h) Input and output signal wiring for remote start/stop as required by plans/specs.
 - 3) Remote station contacts to the corresponding terminal inputs in the main control panel.

D. SPECIALTY TOOLS, SPARE PARTS AND LUBRICATION

- 1. Duperon does not typically recommend the purchase of additional spare parts, though some customers prefer to have them on hand.
- 2. Plane Bearing Kit includes:
 - a. Side Auger Supports (2)
 - b. Upper/Lower Auger Supports (2)
 - c. FHSCS: ¼-20 x 1.00 LG (24)
 - d. Washer: ¼ Flat SAE (24)
 - e. Nut: ¼-20 Nylock (24)
 - f. Grease Tube (14oz.) (1)
 - g. Never-Seez (1oz.) (1)

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PART 3 EXECUTION

3.1 SHIPMENT

- A. Shipment of all equipment shall be coordinated to allow the screen, sluice and washer compactor shipment as one complete integrated assembly unless otherwise specified by the customer, contractor, or engineer.

3.2 INSTALLATION

- A. Equipment shall be installed in strict conformance with the manufacturer's installation instructions, as submitted with Shop Drawings, Operation and Maintenance Manuals and/or any pre-installation checklists. Installation shall utilize standard torque values and be installed secure in position and neat in appearance. Installation shall include any site preparation tasks as required by the engineer or manufacturer; such as unloading, touch-up painting, etc. and any other installation tasks and materials such as wiring, conduit, controls stands as determined by the customer and/or specified by the manufacturer.
- B. Anchor Bolts: Anchor bolts and nuts shall be 304 stainless steel and furnished for each item of equipment by the CONTRACTOR.
 - 1. Provide per Section 05051.
 - 2. Anchor bolt template drawings shall be included in the submittal to permit verification of the location structural elements, new or existing in the concrete.
 - 3. Anchor bolt sizes, quantity and requirements will be indicated on the submittal drawings. Quantity is site specific but typically each Barscreen assembly requires (8) to (12) 1/2" dia. x 4 1/2" Lg. embed HILTI HAS RODS w/ HIT-RE 500 V3 adhesive system anchor bolts for Mechanical Screen anchorage and typically (8) to (12) 3/8" dia. x 3 3/8" Lg. embed HILTI HAS RODS w/ HIT-RE 500 V3 adhesive system anchor bolts for the Return Guide/Closeouts anchorage.

3.3 TESTING

- A. After completion of installation, CONTRACTOR shall provide for testing and shall be performed in strict conformance with the manufacturer's start up instructions. Testing of the bar screen, sluice and washer compactor shall demonstrate that the equipment is fully operational by picking up and depositing materials into specified containment.
- B. Field certification shall include inspection of the following:
 - 1. Verify equipment is properly aligned and anchored per the installation instruction and drawings. Assure the bar screen, sluice, and washer compactor unit is square, flat and unobstructed with required clearances maintained.
 - 2. Assure controls and instrumentation work in all modes.
 - 3. Check equipment for proper operation of debris blade, scrapers, etc as well as completion of the Start-Up requirements in the installation guide.

3.4 ONSITE TECHNICAL ASSISTANCE

- A. Manufacturer shall provide services to include Installation Certification, and shall include (1) day for Start-Up and (1) day for Training. Manufacturer shall be given minimum 14 days notification prior to the need for such services. To assure the best outcome for the Owner and

Contractor, the Contractor shall provide certification for completion of the PRE-COMMISSIONING CHECKLIST.

- B. See specification 11351 – Screen Performance Testing for additional information.

END OF SECTION

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SECTION 11350 (B)

MECHANICALLY CLEANED FINE BAR SCREENS

PART 1 GENERAL

1.1 SCOPE

- A. Supply all labor, materials, equipment and incidentals required to install and place into operation the fine screening system as shown on the Drawings and as specified herein.

1.2 REFERENCE STANDARDS

- A. The properties of all materials, design, fabrication and performance of the equipment to be furnished under this section shall be in accordance with the latest issue of applicable standard specifications. The governing authorities of these standards are listed below.
 1. AICS, American Institute of Steel Construction
 2. AISI American Iron and Steel Institute
 3. ANSI, American National Standards Institute
 4. ASCE, American Society of Civil Engineers
 5. ASME, American Society of Mechanical Engineers
 6. ASTM, American Society of Testing and Materials
 7. AWS, American Welding Society
 8. IBC, International Building Code
 9. IEC, International Electric Code
 10. IEEE, Institute of Electrical and Electronics Engineers
 11. NEC, National Electrical Code
 12. NEMA, National Electrical Manufacturers Association
 13. Underwriters Laboratory (UL and cUL)

1.3 RELATED SECTION

- A. Specification 01300 – Specifications
- B. Specification 01400 – Quality Control
- C. Specification 01730 – Operation and Maintenance Manuals
- D. Specification 01950 – Sequence of Construction and Special Project Requirements
- E. Specification 02050 – Demolition Work
- F. Specification 05051 – Anchors
- G. Specification 15000 – Equipment, General
- H. Specification 15170 – Motors

1.4 SUBMITTALS

- A. Refer to Specification 01300 – Submittals for additional information on submittal and shop drawing requirements.
- B. Submittals shall be provided to the engineer that includes all the following information:
 - 1. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section and Part 1, 2, and 3 Sub-Sections, stating paragraph-paragraph, compliance with the Specifications, each minor nonconformity that is within the intent of the Specification and proposed nonconformities. Provide short descriptions of minor nonconformities, and detailed explanation and drawings of other nonconformities.
 - 2. Certified shop drawings showing all important details of construction, dimensions and anchor bolt locations.
 - 3. Descriptive product literature.
 - 4. Schematic electrical wiring diagram and electrical controls information.
 - 5. Complete motor and drive data.
 - 6. The total weight of the equipment.
 - 7. A complete bill of materials of all equipment.
 - 8. A valid certificate of registration naming manufacturer, and supplier if equipment is relabeled, as ISO 9001:2015 certified.

1.5 QUALIFICATIONS

- A. All the equipment specified under this Section shall be supplied by a single manufacturer whose Quality Management System is ISO 9001:2015 certified and applicable to the manufacture of water and wastewater treatment equipment.
- B. If equipment is not manufactured by supplier, including welding and machining, the name and contact information of manufacturing facility must be supplied. If more than one manufacturer is used all companies and facilities must be provided.
- C. If patents protecting equipment are not owned by supplier, then an affidavit must be supplied stating owner of design and expiration of licensing agreement.

1.6 DESIGN REQUIREMENTS

- A. System Description
 - 1. The fine screen will have a continuous stainless steel belt that automatically rotates within the internal guide system of the static frame.
 - 2. The fine screen herein specified will be of the center flow type. The flow enters the inside of the continuous belt and exits through both sides and the bottom of the belt.
 - 3. The screen will be installed into the channel as shown on the contract drawings to accommodate the flow pattern through the screen belt.
 - 4. The solids will collect as a mat on the inside of the continuous belt. The belt will intermittently rotate and elevate the solids to the discharge point. Larger objects will be picked up by a series of hooks and/or trays placed at regular intervals.
 - 5. The solids will be removed at the top of the screen by two spray bar headers positioned on the outside of the belt.

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6. The screenings will drop into an internal hopper and be fed to the screening handling system.
7. The continuous belt will be directly driven by drive sprockets that shall support and rotate the grid assembly.
8. The screen will be totally enclosed and have access covers that will be lightweight and easily removable for maintenance.
9. The Washing Compactor will be positioned next to the screening channels and will be fed by a sluice system.
10. The Washing Compactor will be adequately sized to handle all the screenings and wash water that will be generated by the screen at peak flow. The system will be required to wash the screenings to reduce the organic content and compact the remaining solids into a dry plug.
11. The Washing Compactor will generally comprise of a screw auger rotating within the washing and drainage trough, a wash water system, a compaction zone and an outlet chute arrangement.
12. All stainless steel (including frame, grid and drive components) mentioned below as stainless steel shall be T304 stainless steel. All hardware shall be T316 stainless steel.

B. North System Performance – The fine screening system will be designed to meet the following design parameters:

- | | | |
|-----|---|--|
| 1. | Number of screens | 2 |
| 2. | Peak flow per screen | 30 MGD |
| 3. | Velocity through the grid | 3.6 ft/s |
| 4. | Screen grid opening | 6 mm |
| 5. | Head loss at peak flow | 9 inches @ 30% blinding and 78 inches upstream water level |
| 6. | Structural design differential of frame/grid blinding | 48 inches minimum @ 100% |
| 7. | Drive design differential (operating) | 48 inches minimum |
| 8. | Screen grid supporting drive sprockets | 2 minimum – all stainless steel |
| 9. | Channel width | 54 inches |
| 10. | Channel height | 96 inches |
| 11. | Number of Washing Compactors | 2 |
| 12. | Diameter of screw | 10 inches |
| 13. | Minimum diameter of shaft | 2.75 inches |
| 14. | Screen wash water requirements | 30 GPM @ 40 PSI (EACH) |
| 15. | Washing Compactor wash water req. | 12 GPM @ 40 PSI (EACH) |
| 16. | Sluice wash water req. | 10 GPM @ 40 PSI |

C. South System Performance – The fine screening system will be designed to meet the following design parameters:

- | | | |
|----|---|--|
| 1. | Number of screens | 1 |
| 2. | Peak flow per screen | 30 MGD |
| 3. | Velocity through the grid | 5.1 ft/s |
| 4. | Screen grid opening | 6 mm |
| 5. | Head loss at peak flow | 9 inches @ 30% blinding and 60 inches upstream water level |
| 6. | Structural design differential of frame/grid blinding | 48 inches minimum @ 100% |
| 7. | Drive design differential (operating) | 48 inches minimum |
| 8. | Screen grid supporting drive sprockets | 2 minimum – all stainless steel |
| 9. | Channel width | 120 inches |

10.	Channel height	78 inches
11.	Number of Washing Compactors	1
12.	Diameter of screw	10 inches
13.	Minimum diameter of shaft	2.75 inches
14.	Screen wash water requirements	30 GPM @ 40 PSI (EACH)
15.	Washing Compactor wash water req.	12 GPM @ 40 PSI (EACH)
16.	Sluice wash water requirements	5 GPM @ 40 PSI

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. The equipment shall be the Center Flow Screen and Washing Compactor as provided by Hydro-Dyne Engineering, Inc., Clearwater, FL. No other substitutions are allowed.
- B. If submitted equipment requires arrangement differing from that specified, prepare and submit for review complete structural, mechanical, and electrical drawings and equipment lists showing all necessary changes and embodying all special features of equipment proposed. Any changes are at no additional compensation and the Manufacturer will be responsible for all engineering costs of redesign by the Engineer, if necessary.

2.2 THE CENTER FLOW SCREEN

- A. Laced Link Grid - The Continuous Screening Belt
 1. The screenings belt will consist of heavy duty stainless steel laced links connected in parallel and separated by Delrin spacers to maintain specified opening. Each laced link hook element shall be fabricated from 14 gauge stainless steel. Each straight element shall be fabricated from 16 gauge stainless steel. All elements shall be a minimum of 1 inch wide forming a slotted opening of the specified width and minimum 1 inch deep in the direction of flow. Hooks on elements shall form horizontal lifting trays or shelves for removing large solids and rags every 8 inches.
 2. The stainless steel laced links will be connected by heavy duty stainless steel axles every 8 inches to form a continuous belt that will rotate within the frame's guide system. The axle design will allow the row of laced links to pivot. The links shall support the screening grid and bear tension loads across the entire width and length of the screen belt.
 3. Links, hooks and screening lifting members must be manufactured out of stainless steel. Plastic is not acceptable.
 4. The axles will be extended to fix a UHMWPE guide link to the side of each row of laced link elements. These guides will interlock to create a continuous guide link system that will slide within the frame.
 5. Guide links shall be precision machined from solid virgin UHMWPE. Injection molded links are not acceptable.
 6. The heavy duty guide links will be minimum 2 inches thick to protect against undue wear from grit and will be specially machined to form a closure seal between the rotating belt and the static frame.
 7. The seal shall be continuous from grade level through the water flow forming an uninterrupted closure between the traveling screen grid and the stationary frame. The

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seal shall be fixed to the screen frame and be adjustable so that it will remain in contact with the rotating screen belt at all times.

8. Guide systems that use rollers, stainless or hardened steel chains will not be acceptable.
9. Grid sealing systems that use neoprene seals or stainless steel hinges will not be acceptable.
10. Grid to frame sealing systems that use adjustable UHMWPE strips attached to the frame will not be acceptable.
11. Intermittent stainless steel laced link elements that form sharp hooks will be regularly placed along the face of each row of the grid to effectively remove large particles.

B. The Frame

1. The continuous belt will rotate within a heavy duty stainless steel static support frame that shall be a rectangular box construction.
2. The guide link system will travel around a stainless steel guide wear track that is integral to the support frame. Top and bottom wear tracks shall be bolt in and field replaceable.
3. There shall be a removable inspection panel located directly beneath the drive allowing easy access to the grid drive sprockets, drive shaft and screenings collection hopper.
4. The design will ensure that the support frame meshes with the closure seal on each guide link to prevent passage of screening material and grit particles.
5. All components of the lower wear tracks shall be bolt in, field replaceable and manufactured from stainless steel.
6. The frame shall accommodate stainless steel protective covers designed to prevent leakage and contain spray wash. All access covers for maintenance will be lightweight and easily removable. Screens with covers requiring neoprene, rubber or plastic seals are not acceptable.
7. The screen manufacturer will supply the stainless steel angled filler plates to connect from the upstream corners of the support frame to the channel walls.
8. The back-plate of the screen shall be furnished with a bypass gate that will allow manual removal for complete flow bypass.

C. The Offloading of Screenings

1. Two stainless steel spray wash headers will be located in the head space of the screen to offload the screenings from the continuous belt.
2. The spray bar will incorporate brass nozzles at 2 inch spaces that can easily be replaced or removed for cleaning.
3. The spray bars will be positioned behind the rotating belt and will backwash the solids into an internal hopper manufactured from stainless steel. The wash water will be used to continuously flush the screenings from the internal hopper into the extended sluice.
4. The addition of a rotating or static brush system to aid offloading will not be acceptable.

D. Screen Drive Mechanism

1. Each screen will have a maximum 1.0 hp, inverter duty electric motor suitable for a 460/3/60 supply and rated for a Class 1 Div. 1 environment. As a minimum, the motor will be TEFC with an IP55 enclosure rating and will conform to NEMA MG-1 requirements. The motor will be located outside of the screen covers and above the top of the channel.

2. The gear reducer shall be directly coupled to a heavy duty shaft machined from solid stainless steel round bar.
3. The drive shaft shall be supported on both ends by grease filled roller bearings. Separate grease-filled self-contained cartridge seals shall be mounted on drive shaft between bearings and frame to eliminate spray wash from entering bearings or gear reducer.
4. The continuous belt will be supported and rotated around heavy duty stainless steel sprockets located on the drive shaft in the head space of the screen.
5. These sprockets will have removable bolted-on lugs that transmit torque directly from the gear reducer to notches on the underside of the UHMWPE guide links. Driving forces shall be transmitted to areas located behind the screen's grid to prevent solids from contacting drive surfaces.
6. Chain driven systems or screens with wheels submerged in the wastewater are not acceptable.
7. Drive systems that use an external track and pinion to drive or push the band against grid weight supporting wear tracks will not be acceptable. Drive shall lift, and be capable of bearing, the full weight of the grid.

2.3 THE SCREENINGS TRANSFER SLUICE

- A. The manufacturer will design and supply a screenings launder sluice system that will collect screenings and wash water from the discharge hopper of the screen and transfer them into the washing compactor(s).
 1. Collected screenings will transfer through the sluice by means of gravity. Mechanically driven conveyors will not be acceptable.
 2. The manufacturer shall supply a solenoid valve that will be plumbed in field into the back plate of the sluice. The contractor will connect to a local plant water supply, and the water supply will provide supplementary transport water.
 3. The sluice will be manufactured from stainless steel. It shall comprise of U-shaped lengths of trough that will be flange connected to the desired overall length.
 4. A change in direction will be achieved using long swept bends that will prevent blockages from occurring.
 5. The sluice system will be designed with a splitter that diverts flow into 1 of 2 compactors for the North screen system.
 - a. The splitter will be fitted with a manual removable gate(s) to divert into any branch of the sluice
 6. Trough wash water system shall be designed by the Manufacturer so that no screening debris hang-up occurs, and 100% of the screenings are flushed to the washer compactor. If this is not achieved, provide a second spray bar with multiple nozzles along with a globe valve for throttling flow and a ball valves for on-off manual control.
 7. The sluice system will include the support leg structure manufactured from stainless steel as needed. The legs will be suitable for anchoring to a concrete floor.
 8. Covers will be lightweight, no more than 6 feet long and bolted for easy removal by a single operator.

2.4 THE WASHING COMPACTOR

- A. The main body will be the washing trough that will receive screenings and wash water directly from the end of the screenings transfer sluice.

- B. The washing trough will house the screw auger and provide a dedicated section to reduce organic content.
- C. The stainless steel drainage section will be slots with 5mm openings and be adjustable to maintain auger alignment. This drainage section shall be removable and easily replaceable in the field with no special tools. The flights of the screw may be fitted with a stiff nylon brush that will maintain contact with the drainage section, preventing blockages. The replaceable brushes will be supplied in pre-coiled lengths with stainless steel removable clamps.
- D. The underside of the washing trough will be a catch pan chute that will divert the water that passes through the drainage section, back to the influent flow with dual outlet plain end pipe connections. The unconnected pipe side will be capped with a rubber compression cap so that it can be removed and the drain piping can be cleaned in necessary. The catch pan will include a flushing connection point for washing and cleaning.
- E. The catch pan will include a separate wash water supply to purge the area of accumulated solids. A single spray nozzle will direct water across the length of the pan toward the outlet. The frequency of cleansing cycles will be controlled through the main control panel.
- F. The steel screw will sit in the washing trough. Washing compactors with shaftless screws are not acceptable as a shaft is required to support the flight and provide necessary torque and compaction.
- G. The auger will be a varied pitch screw aligned at the compaction end by steel wear and anti-rotation bars designed to prevent the compacted screening from spinning with the compaction zone.
- H. The screw will rotate allowing wash water and free organic/fecal material finer than trough openings to escape and return to the plant flow. The wash water will flush the separated organic material through the drainage section in solution or as small particles.
- I. The compacted screenings will be pushed through the compaction zone and pass through and elbow into an outlet chute. The outlet chute will provide for screening expansion and will elevate the dewatering screenings to discharge by gravity into a waste receptacle (by others).
- J. Each washing compactor will have a minimum 5 hp, inverted duty electric motor suitable for a 460/3/60 supply and rated for a Class 1 Div. 2 environment. As a minimum, the motor will be TEFC with an IP55 enclosure rating and will confirm to NEMA MG-1 requirements.

2.5 SPARE PARTS

- A. The manufacturer will supply the following spare parts, per screen supplied, with the equipment:
 - 1. Ten (10) hook links and elements spacers
 - 2. Two (2) grid axles
 - 3. Two (2) guide links
 - 4. Two (2) screen panels
 - 5. One (1) brush for the screw

2.6 ACCESSORIES

- A. The manufacturer will supply the following accessories, with the equipment:
1. Eight (8) 1.5" NEMA 7 brass body solenoid valve
 2. Two (2) 2" wash water strainer
 3. Six (6) wash water pressure gauge

2.7 ELECTRICAL CONTROLS AND ANCILLARY COMPONENTS

- A. General Information - The manufacturer will supply three UL listed main control panels, one screen/compactor panel for each channel, six emergency stop stations, and six local Hand/Off/Auto control stations (LCS) that shall control the equipment offered in this section.
- B. The Screen/Compactor Control Panel shall be a NEMA 4X stainless steel enclosure for indoor installation – Each control panel shall consist of, but not limited to, the following components for each screening system:
1. Main lockout/fused disconnect switch
 2. Uninterruptible Power Supply
 3. Variable frequency screen drive
 4. Compactor motor starter
 5. Control transformer, 500 VA minimum
 6. Programmable Logic Controller (PLC) Allen-Bradley MicroLogix 1400
 7. Operator interface terminal (OIT) Allen-Bradley PanelView Plus 7
 8. Ethernet switch for connection to the PLC, OID and plant SCADA
 9. Programmable control relay with minimum of 5 cycle timers
 10. Fused disconnect
 11. Hour run meter
 12. Fuses and breakers
 13. Motor overload sensor
 14. Panel power light
 15. Screen run/fault lights
 16. Reset pushbutton
 17. Current monitors
- C. Ancillary Control Components -
1. Ultrasonic differential level system consisting of the following per screen:
 - a. NEMA 4X enclosure with viewing window (located in Electrical Room)
 - b. Siemens Hydro-Ranger 200 controller with real-time 4-20 mA output, or equal manufactured by Vega.
 - c. Two (2) NEMA 7 transducers
 2. Local Control Station – NEMA 7 - Each local station panel shall consist of the following components:
 - a. NEMA 7 enclosure
 - b. Hand/Off/Auto switch for each motor (HOA)
 - c. Emergency stop (E-Stop)
- D. Control Operations –
1. Each screen shall be provided with a local control station hand, off, auto (HOA), and an emergency stop station.

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2. The screen and washer compactors shall operate in the manual or automatic mode as follows.
3. When the screen local control station (LCS) HOA switch is in the HAND position the screen shall run continuously. When the HOA is in the OFF position the screen shall not run on any condition. When the HOA switch is in the AUTO position the screen shall run based on the PLC in the control panel as described below.
4. The operator shall be able to select three control modes. Timer mode, combined mode, or level mode. When the timer mode is selected, the screen shall operate based on the preset timer parameters (adjustable). When the level mode is selected, the screen shall operate based on the pre-set level differential setpoints (adjustable), and combined as described below.
5. Under normal conditions, the screen shall be operated in the COMBINED mode controlled by an adjustable on/off PLC cycle timer on a timed basis. The timed operation of the screen will be overridden by a high differential level condition as follows:
 - a. When the differential level reaches a predetermined set point, the screen shall begin operation in low (normal) speed and shall shut down after a predetermined time if the differential level has dropped below the predetermined set point.
 - b. If the differential level increases to a second, higher predetermined set point, the screen shall operate in high speed and shall either shut down after a predetermined time if the differential level is less than the low differential level set point or slow to low speed if the differential level is below the high differential level setpoint but above the low differential level setpoint.
6. When the E-STOP at the LCS is engaged, the screen shall stop all function immediately.
7. The following timers and counter shall be provided in the manufacturer supplied PLC for each screen, timers and counter shall be made adjustable at the manufacturer supplied touch screen interface. Also adjustable by the SCADA nonadjustable over Ethernet link.

Description	Resolution	Initial Setting
Screen Repeat Cycle OFF Time	HR:MIN	00:00
Screen Repeat Cycle ON Time	MIN:SEC	00:00
Screen Run Accumulation Timer	MIN:SEC	00:00
High Differential Water Level Alarm	MIN:SEC	00:00
High Water Level Alarm	MIN:SEC	00:00
High-High Water Level Alarm	MIN:SEC	00:00

- E. Each compactor shall be provided with a local control station hand, off, auto (HOA), and an emergency stop station. And operate as follows:
 1. When the compactor local control station (LCS) HOA switch is in the HAND position the screen shall run continuously. When the HOA is in the OFF position the screen shall not run on any condition. When the HOA switch is in the AUTO position the screen shall run based on the PLC in the control panel and interfaced with the screen controls for sequencing.

2.8 SURFACE PREPARATION AND PAINTING

- A. The majority of stainless steel materials, flanges and piping shall be pickled by means of a four tank system that is in accordance with ASTMs A380. This process is for quality control, removal of heat affected discoloration, surface treatment for corrosive environments and to provide a uniform finish to the stainless steel surfaces. Stainless steel components must be fully submerged in the tanks for complete coverage. Electro-chemical wanding is acceptable on weld finishes that cannot be submerged due to size. Sandblasting, pickling pastes and abrasive cleaners will not be accepted as forms of metal finishing. The drive and grid components do not require pickling.

Tank 1 – detergent bath for the removal of soils, greases, oils and dirt

Tank 2 – rinsing process to remove detergent and residual soils

Tank 3 – two part acid solution for the removal of tightly adhere oxide films

Tank 4 – final rinse process to remove all residual acid

- B. All ferrous surfaces (except stainless steel) shall be coated with a pre-primer, primer, and an exterior top coating, or fusion bonded polyester coating suitable for humid/wet environments for superior corrosion protection.
- C. Motor(s) and gearbox(s) shall be surface prepared to withstand humid/wet environments for superior corrosion protection. Provide coatings per Section 09900.

PART 3 EXECUTION

3.1 WARRANTY

- A. The Manufacturer of the equipment supplied under this specification shall provide a warranty for a period of 24 months commencing on Substantial Completion. The Manufacturer shall guarantee that the equipment furnished is suitable for the purpose intended and free from defects in design, materials and workmanship. In the event that the equipment fails to perform as specified the Manufacturer shall, at his option, promptly repair, modify or replace the defective equipment.

3.2 FACTORY TESTING

- A. The screening system and all components shall be factory assembled and tested for a minimum of 24 hours prior to shipment. The equipment shall be shipped fully assembled and shall be capable of being set in place and field erected by the Contractor with minimal field assembly.
- B. During the factory test period the screening system shall be adjusted as required assuring proper operation on completion of the field installation. The Manufacturer shall supply a certification of the completion of the factory testing of the assembled screening system and appurtenances and shall certify as to the equipment being in satisfactory operating condition at

time of shipment. The Engineer and/or Owner may, at their own option and expense, witness the factory test.

3.3 DELIVERY AND STORAGE

- A. The screening system shall be appropriately crated and delivered to protect against damage during shipment.
- B. An authorized representative of the Contractor shall inspect the screens on delivery to the jobsite and shall report any damage or missing components to the Manufacturer and the Engineer within 72 hours of receipt of the shipment.

3.4 INSTALLATION

- A. The installation of the equipment shall be as indicated on the drawings and in strict accordance with the Manufacturer's instructions and recommendations.

3.5 FIELD TESTS, ADJUSTMENTS AND COMMISSIONING

- A. The equipment shall be shipped completely factory assembled. Contractor shall verify all access dimensions, channel dimensions, and any interior building dimensions to ensure equipment may be installed as a factory assembled units.
- B. After completion of the installation, the equipment shall be inspected and certified by an authorized representative of the Manufacturer as being in compliance with the Manufacturer's recommendations and requirements. At such time as the Manufacturer has deemed the installation to be acceptable, the Manufacturer's authorized service representative shall make any required adjustments and shall start the equipment to assure proper operation.
- C. The Manufacturer's authorized representative shall provide instruction to the plant personnel as to the operation and maintenance of the equipment including commissioning, shut down, on-line operations, lubrication and preventative maintenance.
- D. Manufacturer shall state field service rates for a Service Engineer to Owner and Contractor. In the event that the field service time required by this section should not be sufficient to properly place the equipment into operation, and the requirement for additional time is beyond the manufacturer's responsibility, additional time shall be purchased by Contractor to correct deficiencies in installation, equipment, or material without additional cost to Owner.
- E. The Contractor shall include in his bid, the cost of the above referenced authorized service representative for a minimum of two (2) trips totaling three (3) eight hour days onsite to complete the certifications and training described in this specification section.
- F. Field Performance Test

END OF SECTION

SECTION 11351
SCREEN PERFORMANCE TESTING

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. Each screen manufacturer provided screen performance criteria during the design process. The purpose of this specification is to determine the actual screen performance relative to previously stated performance.
- B. The performance is based on the testing as procedures establish in the UKWIR National Screen Evaluation Facility, Inlet Screen Evaluation Comparative Report (1999 – 2015), hereinafter referred to as UK Screen Report. Screen performance is stated as Screening Capture Ratio, defined in Section 3 of the noted report as:

$$SCR = [Y/(Y+Z)] * 100\%$$

Where:

SCR = Screen Capture Ratio

Y = wet solids captured by the screen (lbs.)

Z = wet solids captured downstream of the screen (lbs.)

- C. The stated and required Duperon screen performance is 35% SCR.
- D. The stated and required Hydro-Dyne screen performance is 65% SCR.

1.2 SUBMITTALS

- A. Provide a Screen Performance Testing work plan detailing the requirements of this specification, including the materials and equipment required, layout, responsibilities, schedule, etc.
- B. Provide cut sheets for all materials described below.

1.3 QUALITY ASSURANCE

- A. Contractor to hire firm third-party firm to perform the tests.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Two sample containers constructed with 3 mm perforated plates to capture screenings and allow to drain.
- B. 5-gallon sample containers with submersible removable lid
- C. Calibrated weight scale

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PART 3 EXECUTION

3.1 PLANNING

- A. Contractor shall schedule an on-site meeting with the Engineer and Owner to discuss the details of the Screen Performance Testing work plan.
- B. Contractor to bring all sampling materials to meeting.

3.2 FIELD TESTS

- A. Pre-Test
 1. Screen Channel shall be isolated and the channel full.
 2. Remove all screenings from screen, sluice, etc.
 3. Obtain tare weight of each perforated sample containers
- B. Test Initiation
 1. Owner to open channel gates and start screen.
 2. Collect all screen materials from screen discharge and place in perforated sample container.
 3. Continuously collect 5-gallon container samples (minimum 30 sample buckets). Sample must be taken in the center of the channel, and the container opened under water at mid-height.
 4. Pour 5 gallon contents into perforated sample container allowing contents to drain.
 5. Run test for a minimum of 30 minutes as agreed to by Contractor and Engineer.
 6. Allow contents of both perforated screening containers to drip dry for 30 minutes (or until drips are no longer observed), then weight. Subtract tare weight and determine screenings weight.
- C. Downstream Screenings Calculations
Calculate Z as follows:
 1. Flow Volume (gal.) = Q (gpm) / test duration (min.)
 2. Sample volume (gal.) = number of buckets x 5 gallons
 3. Flow to Sample Ratio = Flow Volume (gal.) / Sample Volume (gal.)
 4. Z = Weight of downstream screening captures x Flow to Sample Ration
- D. Perform tests 3 times at 3 differing flow rates. (Two at dry weather flow (< ~20 MGD) and one at wet weather flow (> ~25 MGD))

3.3 DATA COLLECTION

- A. Date, Time, Personnel,
- B. Flow (initial and end), No. of downstream sample buckets
- C. Tare weights and screenings containers weight

END OF SECTION

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SECTION 11396

ALUMINUM PANELS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. The Contractor shall furnish all labor, materials, tools, equipment, and supervision required to install the aluminum panels, and low profile aluminum panels, as indicated on the Drawings and specified herein, and all other work incidental thereto, except as otherwise noted.
- B. Panels are to be installed on the raw sewage lift station, headworks building exterior, grit channels, and the influent splitter building as shown on the Drawings.
- C. The work under this section is intended to include the necessary materials and workmanship that are required for the completion of this equipment, as shown on the Drawings, unless otherwise specified.
- D. The work shall be complete and ready for satisfactory operation whether or not each item is shown on the Drawings or specifically mentioned in these Specifications.

1.02 ITEMS SPECIFIED ELSEWHERE

- A. Section 01600 – Material and Equipment
- B. Section 1300 – Submittals
- C. Section 01730 – Operations and Maintenance Data
- D. Painting of all piping and equipment installed as a part of this Section shall be as specified in Section 09900, unless specifically called for otherwise in this Section or applicable associated Sections.
- E. Section 15000 – General Mechanical Provisions

1.03 QUALITY ASSURANCE

- A. The panel manufacturer shall modify his standard equipment to meet the minimum values specified for dimensions, design, and the intent of this specification.
- B. Manufacturers shall be regularly engaged in the manufacture of similar panel systems as specified herein and who can demonstrate a minimum of 10 equipment installations of this specified design, in actual service for a period of not less than 5 years.
- C. Erector shall be engaged for at least ten (10) years in the erection of aluminum panels for wastewater treatment tanks.

1.04 DESIGN REQUIREMENTS

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- A. Design Delegation: The design of the aluminum panels shall be delegated to the Contractor. The Contractor may further delegate the aluminum panel design to their subcontractors or aluminum panel manufacturer as applicable.
- B. Governing Design Code: Design for the aluminum panels shall be performed in accordance with the current edition of the Michigan Building Code.
- C. General
 - 1. All components of the panel systems shall be compatible with the temperature and process conditions as specified herein and indicated on the Drawings.
 - 2. The panels shall be designed for a maximum positive pressure of 1" water column inside the covered channel.
 - 3. All panel joints, seams, flashings, and connections to the existing channels shall be designed to minimize air infiltration. Compressible seals and gaskets compatible with the tank service conditions shall be provided at locations as indicated on the Drawings and at all locations required to minimize infiltration.
 - 4. Panels shall be cambered to allow free draining of water. No ponding will be allowed. Drain holes may be used.
 - 5. Structural attachment to the slide gates is not allowed.
 - 6. Panels shall be fabricated with an integral non-skid surface with a coefficient of friction greater than or equal to 0.6 as determined by ANSI/NFSI B101.1.
- D. Specific Locations
 - 1. Aluminum Panel Replacement Type 5: The panels at these locations are intended to replace existing grating. See the Drawings for additional requirements.
 - 2. Low-Profile Flat Panel. North and South Grit Channels (2): The panels at this location are intended to provide a walking and working surface atop the grit channels. Panels shall be removable to allow inspection and maintenance of the equipment within the channel.
 - 3. Low-Profile Flat Panel, South Grit/Bypass Junction (1): The panels at this location are intended to provide a walking and working surface atop the channel.

1.05 SUBMITTALS

- A. Operation & Maintenance manuals and Shop Drawings shall be prepared, submitted and reviewed as outlined in Division 1 of these specifications.
- B. Shop Drawings must be submitted which demonstrate that the proposed panels meet all performance requirements outlined in these specifications and shall include complete structural calculations showing the governing stresses in all members and connections as well as the reaction forces imposed on the existing concrete tank walls. Shop drawing submittals and calculations shall bear the seal of a professional engineer currently registered in the State of Michigan.
- C. A letter of certification signed and sealed by a professional engineer currently registered in the State of Michigan confirming that the aluminum panel is in full compliance with the plans and specifications.
- D. 3"x3" sample of demonstrating construction and roughness of walking surface.
- E. Manufacturer's standard guarantee.

1.06 WARRANTY

- A. The warranty period for all items by this section of the specifications shall be for one (1) year from the date of equipment acceptance as specified in the general conditions.
- B. No equipment shall be supplied by any manufacturer not regularly engaged in the manufacturing and production of aluminum tank panels in the size and character herein specified. The manufacturer must have installed and had in satisfactory use for a period of not less than ten (10) years at least one (1) aluminum tank panel of the same type as unit specified.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. The flat panel(s) shall conform to the specified dimensions. The flat panel(s) shall be clear-span and designed to be self-supporting from the existing periphery concrete walls. Full provisions shall be made to allow for thermal expansion.
- B. If the top of the panel has two separate elevations, an air tight means of drainage shall be provided.
- C. The flat panel deadweight shall not exceed 150 lbs. per removable module. Each module shall be easy to remove and the lifting force shall not exceed the dead weight of the module. The flat panel surface paneling shall be designed as a relatively airtight system under the specified design loading conditions. Dissimilar materials shall be separated from each other through the use of approved gaskets or coatings.
- D. All panels will use 5052-H32, 5052-H36 or 6061-T6.
- E. Gaskets: Neoprene rubber, Hypalon or equal.
- F. All nuts, bolts, washers and other hardware shall be 316 Stainless Steel.

2.2 PERFORMANCE CRITERIA:

- A. Live loads and deflection criteria shall be as noted on the Drawings.
- B. Wind loads: -28 psf (uplift).
- C. Snow loads: 30 psf.

2.3 FLAT PANEL ACCESS AND OBSERVATION HATCHES

- A. Materials
 - 1. Hatches for the panels shall be located and sized as indicated on the drawings.
 - 2. Each hatch lid shall seat and seal to its frame and shall open freely to fully clear the hatch opening and shall include provisions for a padlock.
- B. Performance Criteria

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1. The panels that are accessible to foot traffic shall be capable of supporting a 50 psf load.
2. Hatches shall be equipped with lifting handles and secured with latches that are hand operated without special tools.

PART 3 - EXECUTION

3.1 INSPECTION

- A. The erector shall confirm the alignment and location of bearing plates, surfaces, brackets, saddles, etc. before placing framing members. All bearing surfaces must be clean and free from debris.
- B. The erector shall check the alignment and location of framing members before placing the secondary framing.

3.2 MATERIAL HANDLING AND STORAGE

- A. At the time of delivery, all material should be inspected for shipping and handling damage. Notify the freight company and the manufacturer immediately of any damage.
- B. Protect the surface of aluminum units from cuts, scratches, gouges, abrasions, and impacts. Do not use wire slings unless material is fully protected. Use spreader bars when lifting these materials. Do not drag panels or flashing across one another unless separated by a non-scratching spacer.
- C. Store all panels on edges; do not store flat. Keep all materials covered – do not stack or store other building materials on top of unprotected units. Store materials in a dry location, off the ground, and allow for ventilation.

3.3 FABRICATION & ERECTION

- A. All work shall be executed by mechanics skilled and experienced in the fabrication and the erection of aluminum structures. The flat panel shall be erected plumb and level and in proper alignment by the flat panel fabricator using highly skilled mechanics.
- B. Erection shall proceed according to sequences as shown on the shop drawings.
- C. Shim aluminum framing only with approved shims. The use of scrap, off-fall or other building materials as shims will not be allowed.
- D. Install aluminum framing members on location, as shown on the drawings and the approved submittals. Field modifications (cuts, copes, holes, etc.) other than work shown on the drawings will not be allowed.
- E. Place aluminum deck panels on supporting members as shown on approved drawings. Refer to manufacturer's installation instructions.
- F. Cut and trim aluminum deck panels as shown on the drawings. Adjust into final position with proper bearing and alignment joints, laps, and supports before fastening.

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- G. Attach aluminum deck panels to the aluminum supports as shown on the drawings. Refer to the manufacturer's installation instructions for proper fastener selection and driving techniques.
- H. Provide openings in new deck panels as required for existing and new piping passing through the panels. All openings shall be flashed and sealed with sealant.

3.4 DAMAGED MATERIAL

- A. Replace or repair all damaged material to the satisfaction of the Engineer.

3.5 CLEAN UP

- A. Clean aluminum material as required with soap and water. Use only a soft bristled brush.

3.6 TESTING

- A. Performance criteria for individual panels shall be validated by full-scale tests which represent combined stress and elastic stability conditions. A load meeting the specified concentrated load shall be placed as directed by the Engineer and the maximum deflection created by the load shall be measured.

3.7 CORRECTIVE ACTION PLAN

- A. If any tested panels exceed the specified deflection limit as defined on the Drawings, the Contractor shall develop a corrective action plan to bring the panels into compliance with this specification and the Drawings.

END OF SECTION

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SECTION 11413

GRIT REMOVAL SYSTEM & WASHER

PART 1 GENERAL

1.1 SUMMARY OF WORK

- A. Furnish all labor, materials, tools, equipment, and supervision required to complete Grit Removal System (including Grit Collector and Grit Washer equipment) installation, as indicated on the drawings and specified herein, and all other work incidental thereto, except as otherwise noted.
- B. Contractor shall furnish, install, and place into satisfactory operating condition two (2) Grit Collectors for collecting and condensing grit particles and two (2) Grit Washer units for removing, washing, and conveying grit particles before discharging the material into a dumpster and as shown on the drawings and described in this specification section.
- C. It is the intent of these specifications that all equipment called for under this section shall be supplied by a single supplier.

1.2 ITEMS SPECIFIED ELSEWHERE

- A. Section 01300 – Submittals including Shop Drawings
- B. Section 01730 – Operation and Maintenance Manuals.
- C. Section 05500 – Metal Fabrications.
- D. Section 11112 – Horizontal Recessed Impeller Pumps
- E. Section 11414 – Grit Removal Performance Testing
- F. Section 15000 – Equipment, General.
- G. Section 15060 - Pipe & Pipe Fittings.
- H. Section 15170 - Motors

1.3 SYSTEM DESCRIPTION

- A. The grit collector shall include the following components:
 - 1. Lamella trays and support frame within existing North and South Grit Chambers
 - 2. Lower horizontal shafted grit auger with trough liner, drive motor and gearbox assembly
 - 3. Controls and appurtenances. Control panel shall include necessary starters and breakers for equipment for each grit removal system.

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- B. The grit washer shall include the following components:
1. Grit washer tank installed within Dumpster Room
 2. Central inlet vortex chamber
 3. Coanda tulip for directing inflowing grit slurry in radial direction to a circumferential overflow weir
 4. Conical stratification tank with cover
 5. Stirring device with gear motor
 6. Fluidized grit bed at the bottom of the stratification tank for intensive grit washing and separation of particles dependent on their specific gravity difference
 7. Grit conveying and dewatering auger
 8. Controls and appurtenances

1.4 SUBMITTALS

- A. Shop drawings: Include the following:
1. Provide a copy of this specification section, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the CONTRACTOR with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
 2. A copy of the Contract Document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this Section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
 3. Detailed mechanical and electrical drawings showing the equipment dimensions, locations of connections, weights of associated equipment and wiring diagrams. Mechanical drawing shall provide exploded view detail of pump components.
 4. Make, model, weight, and horsepower of each equipment assembly.
 5. Manufacturer's data, descriptive literature, bulletins, and catalogs indicating the general description, specifications, and limitations for collective system and individual components.
 6. Bill of Materials for equipment showing materials of construction and part numbers.
 7. Motor nameplate data, as defined by NEMA MG 1, motor manufacturer, and including any motor modifications.
 8. Factory finish system.
- B. Informational Submittals:
1. Operation and Maintenance (O&M) Manuals
 2. Warranty Certificate.
 3. Bearing L-10 life calculations.
 4. Installation Inspection Report

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5. Certification of satisfactory field testing of each unit as specified.
6. Field and Performance testing procedures and reports on results

1.5 REFERENCES

- A. Manufacturer shall provide equipment adhering to all references listed below including all related sections within the publications listed. Contractor shall follow all applicable publication sections when installing and erecting equipment as listed below and specified by manufacturer.
 1. American Society for Testing and Materials (ASTM) Publications:
 - a. Section A322: Carbon and Alloy Steel Bar Specifications.
 - b. Section A507-10: Standard Specification for Drawing Alloy Steel, Sheet and Strip, Hot-Rolled and Cold Rolled
 2. Anti-Friction Bearing Manufacturers Association (AFBMA) Publications:
 - a. Standard 9-90 Load Ratings and Fatigue Life for Ball Bearings.
 - b. Standard 11-90 Load Ratings and Fatigue Life for Roller Bearings.
 3. American Institute of Steel Construction (AISC) Publications
 4. American Welding Society (AWS) Publications
 - a. D1.1 Structural Welding Code
 5. American Structures Painting Council (ASPC) Publications

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Each grit collector shall include lamella settling trays and lower horizontal shafted grit auger, and be model HUBER Lamella Grit Trap Grit Wolf® Size 7 manufactured by HUBER Technology, Inc. The substitution policy does not apply to this item.
- B. Each grit washer shall include a coanda tulip for directing inflowing grit slurry in radial direction to a circumferential overflow weir, conical stratification tank with cover, stirring device with gear motor, fluidized grit bed at the bottom, grit conveying and dewatering auger and be model HUBER Coanda Grit Washer, RoSF4 2 manufactured by HUBER Technology, Inc. The substitution policy does not apply to this item.

2.2 GENERAL MATERIALS

- A. Material requirements listed are applicable for the Grit Collector and Grit Washer unless otherwise specified.
- B. All stainless-steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel. No stainless steel components may be fabricated or assembled in a factory where carbon steel products are also fabricated, in order to prevent

contamination by rust. Glass bead or sand blast or chemically treatment processes not based on nitric acid / hydrofluoric acid for stainless steel shall not be allowed.

- C. All welding in the factory shall use shielded arc, inert gas, MIG or TIG method. Filler wire shall be added to all welds to provide for a cross section equal to or greater than the parent metal. Butt welds shall fully penetrate to the interior surface and gas shielding to interior and exterior of the joint shall be provided.
- D. Equipment manufacturer shall furnish all anchor bolts of ample size and strength required to securely anchor each item of equipment. Anchor bolts shall be wedge or epoxy type and set by the Contractor. Bolts, nuts, and washers shall be selected from AISI 316L stainless steel such that they are anti-seizing. Equipment shall be placed on foundations, leveled, shimmed, bolted down, and grouted with non-shrinking grout.
- E. Electric motors, gear reducers, and other self-contained or enclosed components shall have an acrylic enamel finish.
- F. Manufacturer shall provide the following spare parts within package system; one perforated diaphragm (membrane), one complete solenoid valve assembly, and one set of all special tools, if required.

2.3 GRIT COLLECTOR PERFORMANCE DATA

- A. Manufacturer shall provide unit adhering to the following performance criteria.
 - 1. Grit Collector

Number of Units	2 – North & South Grit Collectors
Peak Design Flow per Unit	30.0 MGD
Average Flow per Unit	18.5 MGD
Grit Removal Efficiency @ Peak Flow	90% ≥ 212 micron
Grit Removal Efficiency @ Average Flow	95% ≥ 125 micron
Total Lamella Surface Area per Unit	1442 ft ²
Loading Rate @ Peak Flow	14.46 GPM/ft ²
Outlet Weir Headloss @ Peak Flow (North)	6 inches
Outlet Weir Headloss @ Peak Flow (South)	6 inches

2.4 GRIT COLLECTOR MATERIALS & DETAILS

- A. The entire unit shall be manufacturer from AISI 304L stainless steel unless otherwise noted.
- B. Grit Collector:
 - 1. Grit particles shall flow into the grit collector and through the lamella tray inserts, trays where grit shall settle out by gravity through the lamellas and drop down to the bottom of the concrete grit tank. Flow shall continue through the system and over the outlet channel weir.
 - 2. Grit collected at the bottom shall be removed axially by a time-controlled shafted horizontal grit auger conveyor and sent to a collection chamber. A grit slurry pump as specified in Section 11112 shall pump the grit slurry mixture out from the collection chamber by non-continuous operation and into a Grit Washer unit for grit treatment.
 - 3. Side baffles shall be included in 304SS construction with lifting points, 0.12” (3mm) thickness, and shall be mounted directly to the front of the lamella tray package frame,

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as shown on the drawings. Baffles shall have sturdy neoprene gasket bolted to the downstream face of the baffle along the vertical edge of baffle to be installed near the lamella plate. Gasket shall be wide enough to seal the space between the side baffles and lamella plates, approximately 2". Baffles will be fabricated and installed by the Contractor per the details on the Drawings.

4. Front baffle shall be included in 304SS construction with lifting points, 0.12" (3mm) thickness, and shall be mounted directly to the concrete channel floor by anchor bolts.

C. Lamella Tray

1. Lamella tray inserts shall be made from polypropylene material and shall be constructed within a 304L stainless steel lamella tray support frame. The spacing between each lamella plate shall be 3.14-inches (80mm) and shall have a thickness of 1/4 inches (6 mm). Lamella packages shall be double tray version that shall be supported to a 304L stainless steel structural frame and attached to the concrete channel walls by supporting steel angles. Each double lamella tray package shall have a minimum width of 9.75-feet, height of 6.48-feet and depth of 3.6-feet. The overall width of channel required shall not exceed 11-feet.
2. Lamella trays shall be sloped 55 degrees for enhancing grit capture efficiency and shall be a removable design from the channel. Trays that are non-modular to facilitate ease of removal for maintenance are not acceptable.
3. Support frame and lamella trays shall be assembled on site by Contractor before installation into concrete chamber.

D. Grit Auger

1. The horizontal grit auger shall have a minimum diameter of 12.75" (324mm) with a minimum shaft diameter of 4.5" (114mm). The auger flights shall be a minimum of 1/4" (6mm) thick.
2. The horizontal grit auger shall be supported by the drive at one end and along their length by sectional bearing liner that shall have a thickness of 0.315" (8mm) and shall be constructed of high-density polyethylene (HDPE) material. Grease lubricated bearings are not acceptable. A trough constructed of 316 stainless steel shall be provided with the auger. Trough shall be designed to restrain auger liners from movement and allow for replacement of the liner with the use of removable restraining brackets.
3. The drive ends of the horizontal auger shaft tube shall be machined and shrink-fitted with solid stainless-steel stubs. The horizontal grit auger shall be a two-section design to facilitate ease of installation and maintenance as required.
4. Wall pipe shall be provided for drive end of auger to pass through the wall and allow for connection to drive motor and gearbox assembly located in the dry well. Lantern shall be provided to connect wall pipe to gearbox assembly and house auger gland seal assembly. Cover plate constructed of 304SS shall be provided to seal wall penetration.
5. The grit auger shall transport grit to the collection chamber before pumping by timer control.
6. The horizontal grit auger motor power shall be a minimum of 2.0 HP. The auger shall be driven by a shaft mounted gearbox and motor. The gearbox shall have a minimum service factor of 1.0 equivalent to an AGMA Class I rating.
7. The horizontal grit auger drive shall be equipped with a 3-phase, 60 Hertz, 230/460 volt, Class 1, Division 1, continuous-duty motor with leads to a conduit box for

outdoor operation. The motor and gearbox shall be mounted to a stainless-steel plate and fastened to the concrete channel walls.

8. Chain drives, belt drives, hydraulic drives for the transport auger will not be acceptable for this project.
9. Manufacturer will provide alignment and installation instructions for the Contractor to follow closing to confirm the auger is aligned within the channel.

2.5 GRIT WASHER PERFORMANCE DATA

- A. Manufacturer shall provide unit adhering to the following performance criteria.

1. Grit Washer

Number of Units	2
Grit Processing Capacity per Unit	1.5 ton/hr
Maximum Pumped Flow Rate	300 GPM
Removal Efficiency @ Design Flow	95% ≥ 106 micron
Maximum Volatile Content @ Design Flow	5%
Maximum Water Content @ Design Flow	10%
Minimum Weir Length	19.6 inches
Headloss @ Design Flow	9.84 inches
Approximate Empty Weight	2470 lbs
Approximate Loaded Weight	15880 lbs
Wash Water Consumption	22 GPM
Wash Water Minimum Pressure	29 psi
Tank Water Surface Area	30.5 ft ²
Weir Overflow Rate including wash water	0.031 ft ² /sec

2.6 GRIT WASHER MATERIALS & DETAILS

- A. Two Grit Washer units shall be installed within the Dumpster Room as shown on the Drawings.
- B. Grit Washer Tank
1. Water containing grit from a grit chamber shall be introduced through a 6 inch inlet into the vortex chamber, creating a rotating flow pattern, and through the Coanda tulip into the grit washer tank. The maximum allowable influent velocity into the grit washer tank shall be less than 0.5 ft/s. The grit slurry mixture shall be fed directly to the grit washing unit without the need for additional screening via a drum screen, designs requiring a screen to meet the performance requirements shall not be allowed. Designs incorporating a tangential side inlet entry shall not be acceptable.
 2. The inlet connection of the grit washer unit shall be rotatable 360 degrees for site adjustment. Designs that incorporate a fixed inlet connection or that rotate less than 360 degrees shall not be allowed.
 3. The water flow is directed by the Coanda from an axial flow to a radial flow towards the overflow weir that is provided at the circumference of the grit washer tank. This change of the flow direction leads to effective sedimentation of the grit towards the bottom of the grit washer tank. The grit washer tank shall have a minimum of 0.10" wall thickness.
 4. The classified water shall pass over the overflow weir with a length of 19.6-feet and discharge out of a single 8-inch clean water outlet.

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5. Effective stratification of particles, depending on their specific density, but not depending on their particle size and weight, shall be achieved within the conical portion of the grit washer tank.
6. A 4-inch connection with an automatically operated one quarter-turn ball valve shall be provided for removal of organic material out of the conical section of the tank. The ball valve shall be directly flanged to the conical tank without any adapter or connection pieces to avoid clogging issues. The ball valve shall have a PVC body and ball to prevent binding when in contact with abrasive materials. Metallic ball valves which can bind in highly abrasive applications shall not be acceptable.
7. A 110VAC, single phase, electrically operated actuator shall be provided to provide automatic control of the ball valve. The actuator shall only be acceptable for the grit washer unit. The actuator shall be suitable for operation in a Class 1, Division 1 hazardous location. The stirrer shall move organic matter toward this connection. Organics outlet pipe shall be connected to the overflow outlet piping and shall discharge flow downstream of the grit removal system.
8. A 110VAC, single phase, pressure probe by VEGA shall be mounted in the bottom of the grit settling area to monitor the grit level within the tank and to control the operation of the grit stirrer and grit removal auger. The pressure probe shall be suitable for installation in a Class 1, Division 1 hazardous location.

C. Fluidized Grit Bed

1. A fluidized grit bed shall be maintained in the bottom portion of the grit washer tank. Within this fluidized bed, the grit is intensively washed and organic material is effectively removed from mineral particles.
2. The grit washer shall be designed for a water supply of 22gpm with a minimum pressure of 29psi with a single 1-inch connection point for connecting to the treatment plants final effluent water supply.
3. Wash water shall be introduced into the bottom of the grit washer and dispersed through a perforated diaphragm to generate the fluidized bed in the bottom portion of the grit washer. This wash water shall also effectively flush the organic components out of the fluidized bed towards the overflow weir.
4. Wash water through the perforated plate diaphragm shall be distributed uniformly in order to reduce grit sedimentation on the bottom of the grit tank. The perforated plate neoprene diaphragm shall have a 2mm thickness.
5. The wash water manifold will be provided with a variable area flow meter with a transparent PVC casing to allow visual inspection of the internal float for manual flow rate confirmation. The variable area flow meter shall be factory installed and attached to the grit washer unit before shipment.
6. Wash water control shall be provided via a 1-inch 110V, 60Hz, Class 1, Division 1 solenoid valve.

D. Grit Screw

1. Washed grit shall be removed through a central tube at the bottom of the grit washer. The stirrer shall move washed grit to the central tube. The grit to be removed shall drop into an inclined auger. This auger shall dewater and convey the grit above the level of the overflow weir. The washed and dewatered grit is discharged at the upper end of the auger.
2. Its inlet hopper shall be flange-connected to the grit discharge tube. The auger shall have a discharge height of 96" (2443 mm) above the floor. Its inlet hopper shall be provided with a 3" diameter (DN 80) drain connection that is provided with a ball

valve. The drain connection shall also be provided with a 3/4" flush connection with ball valve.

3. The screw conveyor trough shall be made of minimum 10/64 inch (4 mm) thick stainless steel and shall have a minimum trough diameter of 13.8-inches.
4. The screw shall be shafted and shall be made of stainless steel. A shaft-less screw is not acceptable. The lower end of the screw shaft shall be supported by a chilled cast-iron stub bearing with a maintenance-free ceramic sleeve. Wear strips are not acceptable.
5. The grit screw design shall have intelligent screw flights preventing clogging issues within the grit screw.
6. A screw drive shall be provided at the upper end of the auger. The motor shall be continuous duty rated and shall be selected to match the duty of the particular grit conveying screw. The drive unit shall be directly coupled to the grit conveying screw drive shaft.

E. Grit Stirrer

1. The center stirrer shaft diameter shall be 60 mm and shall have a thickness of 5 mm. The stirrer arms shall be 30 mm in diameter and constructed of 304L stainless steel. The stirrer shall consist of a minimum of 2 arm sections. The stirrer design shall promote better discharge of organics, grit bed fluidization, and ability to discharge larger stones.

F. Motors

1. Grit Screw

Maximum Motor Speed	1800 rpm
Service Factor	1.15
Rating	480 VAC, 3ph, 60 Hz
Location Rating	Class 1, Division 1
Maximum Power Screw Drive Motor	1.5 HP

- a. Torque must be sufficient to start and operate grit washer without exceeding nameplate ratings for current and power.

2. Grit Stirrer

Maximum Motor Speed	1800 rpm
Service Factor	1.15
Rating	480 VAC, 3ph, 60 Hz
Location Rating	Class 1, Division 1
Maximum Power Stirrer Drive Motor	0.75 HP

- a. Torque must be sufficient to start and operate grit washer without exceeding nameplate ratings for current and power.

2.7 CONTROLS

- A. All controls necessary for the fully automatic operation of the grit system shall be provided, including a total of two (2) NEMA 4X main control panels with each individual panel controlling one (1) GritWolf grit removal system, one (1) RoSF4 grit washer, and two (2) grit slurry pumps, as described here in. A NEMA 7 local control station per each individual machine shall be provided.

1. The North grit removal system panel shall control two (2) grit slurry pumps (Grit Pump No.1 and No. 2) in a duty/standby configuration.

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2. The South grit removal system, panel shall control two (2) grit slurry pumps (Grit Pump No. 3 and No. 4) in a duty/standby configuration.
- B. The electrical control system shall provide for automatic control of the grit washer via a signal from the feed pump control panel. The grit removal system screws shall be operated by timer.
- C. Each control panel shall be suitable for outdoor, wall-mounting. Enclosure shall be NEMA 4X stainless steel with continuous hinge and lockable door latch, and shall include the following:
1. Door-interlocked and fused disconnect
 2. 600 VAC terminal block
 3. Uninterruptible Power Supply
 4. NEMA motor starters and Circuit Breaker Branch Circuit Protection for all electrical motors
 5. Control power transformer with 120 VAC transient voltage surge compressor (TVSC) and fused primary and secondary
 6. Programmable logic controller (PLC), Allen Bradley Micrologix 1400
 7. Operator Interface Terminal (OIT), Allen Bradley 10" PanelView Plus 7
 8. Pilot lights for
 - a. Control power on (white)
 - b. Horizontal grit screw running (green)
 - c. Grit Screw running (green)
 - d. Grit Stirrer (green)
 - e. Organic Valve open (green)
 - f. Grit Screw fault (red)
 - g. Grit Stirrer fault (red)
 - h. Organic valve fault (red)
 - i. Grit pump running (green)
 - j. Grit pump fault (red)
 9. E-stop push button (red)
 10. Reset push button (black)
 11. Door mounted elapsed time meters for the following:
 - a. Horizontal grit screw drive
 - b. Grit Washer Screw drive
 - c. Grit Washer Stirrer drive
 12. Remote dry contact inputs for the following:
 - a. Machine start
 - b. One spare input
 13. Remote dry contact outputs for the following:
 - a. Horizontal grit screw running
 - b. Grit washer running
 - c. Grit Pump running
 - d. Faults
 - e. E-stops
 - f. Two spare outputs
 14. Flashing alarm light and alarm horn with silencer-reset button
 15. Plastic Nameplates
 16. Seal water solenoid valves for each pump shall be wired directly to the motor controls such that the solenoid energizes (opens) when the pump is started and deenergizes (closes) when the pump stops.

D. LOCAL CONTROL STATIONS

1. Control Power On-Delay: Each time the control panel power supply is cycled, the PLC will allow all solid-state devices to become fully energized before enabling the control power circuit.
2. Each grit washer shall be provided with a NEMA 7, Cast Aluminum Local Control Station. Each Local Control Station Shall be equipped with the following devices
 - a. Hand-Off-Auto selector switches for the following
 - 1) Grit Washer drive
 - 2) Grit Washer Stirrer drive
 - 3) Grit Washer solenoid valve
 - b. Grit Washer forward-off-reverse
 - 1) Grit Washer drive
 - c. E-stop pushbutton (red)
 - d. The stirrer, grit screw, organics valve, and wash water selector switches must all be in the auto position for the grit washer to function in the auto mode.
 - e. If the stirrer, grit screw, or organics valve are faulted, the stirrer, grit screw, organics valve, and wash water will not function in the auto mode.
 - f. When the stirrer hand-off-auto selector is in the hand position, the stirrer will run continuously.
 - g. When the stirrer hand-off-auto selector is in the auto position, the stirrer will operate per the auto sequence detailed below.
 - h. When the grit screw selector is in the hand position, the grit screw will cycle on and off with the grit screw for-off-rev selector.
 - i. When the grit screw selector is in the hand position and the forward direction is selected, the grit screw will cycle continuously in the forward direction.
 - j. When the grit screw selector is in the hand position and the forward direction is selected, the grit screw will cycle continuously in the forward direction.
 - k. When the grit screw selector is in the hand position and the forward direction is selected, the grit screw will cycle continuously in the forward direction.
 - l. When the grit screw selector is in the hand position and the reverse direction is selected, the grit screw will cycle continuously in the reverse direction. This switch will spring return from rev to off.
 - m. When the grit screw selector is in the auto position, the grit screw will operate per the auto sequence detailed below.
 - n. When the organics valve selector is in the open position, the organics valve will open and remain open.
 - o. When the organics valve selector is in the close position, the organics valve will close and remain closed.
 - p. When the organics valve selector is in the auto position, the organics valve will operate per the auto sequence detailed below.
 - q. When the wash water selector is in the hand position, the wash water will run continuously.
 - r. When the wash water selector is in the auto position, the wash water will operate per the auto sequence detailed below.
 - s. The grit washer will start an automatic cycle based on (2) conditions: (1) once the feeding equipment is running. (2) once a call to run has been received from the SCADA system.
 - t. The feeding equipment contact or the call to run signal from SCADA must be maintained for the time set in the grit cycle on-delay timer before the grit system will start an automatic cycle.

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- 1) The wash water will start to run once the automatic feeding cycle starts.
 - 2) When the automatic feeding cycle starts, the stirrer will start to run once the stirrer on-delay timer reaches its setpoint.
 - 3) The pressure sensor will be activated once the automatic feeding cycle starts, and stay active through the entire feeding cycle.
 - 4) The grit screw will start to run once the grit level, as measured by the pressure sensor, rises and stays above the grit density start setpoint for the time set in the start level debounce timer. Once the grit screw is called to run, the grit screw will cycle on and off, on time first, per the settings of the grit screw repeat cycle timers. The on off cycles of the grit screw will continue after the grit density falls below the grit density stop setpoint for the time set in the low level debounce timer.
 - 5) When the automatic feeding cycle starts, the organics valve will close if not already closed and the organics valve open-delay timer will begin timing. Once the valve open-delay timer reaches its setpoint, the organics valve will open. The organics valve will remain open for the time set in the organics valve open duration timer. Once the open duration timer has reached its set point, the organics valve will close. This cycle may be repeated as required during the feeding cycle.
 - 6) The organics valve will never be open while the grit screw is operating. If the grit screw is called to run while the organics valve is opened, the organics valve will close immediately.
- u. Once the grit feeding has stopped the system will go into a shutdown cycle. During the shutdown cycle the remote start signal will no longer be received.
- 1) During the shutdown cycle the stirrer will continue to run after the organics valve completes its final cycle for the time set in the stirrer off-delay timer.
 - 2) During the shutdown cycle the wash water will remain on until the stirrer motor shuts off.
 - 3) Once the system enters into the shutdown mode the pressure sensor will only remain active for the time set on the pressure sensor off delay timer. Once this time has expired the sensor will be de-activated.
 - 4) During the shutdown cycle the grit screw will continue to operate per the feeding cycle sequence of operation as long as the pressure sensor is active.
 - 5) Once the grit screw begins its cycle the pressure switch will remain active until its cycle is complete.
 - 6) During the shutdown cycle the organics valve will open once the pressure sensor becomes de-activated. The organics valve will remain open for a time set on the organics valve open duration timer. Once the open time has expired the valve shall close.
 - 7) Once the organics valve closes, the motor operated valve for the non-potable water flushing connection will open for a set time (initially set for 2-minutes) Once the open time has expired the valve shall close.
- v. An operator may change from normal to continuous feed mode as required from the OIT. During a continuous feed mode, the wash water and stirrer will both cycle per the continuous feed mode, the wash water and stirrer will both cycle per the continuous feed mode repeat cycle on and off timers. The

- pressure sensor, grit screw, and organics valve will run as noted in the grit system automatic feeding cycle. Once the feed signal from the pump or SCADA has been removed, the system will operate as described in the grit system automatic shut down cycle.
- w. The South grit removal system, panel shall control two (2) grit slurry pumps (Grit Pump No. 3 and No. 4) in a duty/standby configuration. An operator can manually reconfigure the grit pump suction and discharge piping with the manually operated valves. From the OIU, an operator may select either grit pump no.3 or no.4 to operate with grit collector No. 2.
 - x. During normal operation grit collector no. 1 and its corresponding grit pump(s) shall be configured to route flows to grit washer no.1 (i.e., north grit removal system) and grit collector no. 2 shall be configured to operate with grit washer no.2. An operator can manually reconfigure the grit slurry piping from each grit collector to route slurry flows to either grit washer unit, with the manually operated valves. From the OIU, an operator may select either grit washer no.1 or no.2 to operate with either grit collector.
 - y. Manual operation of the grit system shall allow grit slurry pumping to alternate between grit collector and grit washer units as required. In the event one of the two grit washers is out of service, an operator can manually reconfigure the grit slurry piping from each grit collector to route slurry flows from both grit collectors to a single grit washer unit, with the manually operated valves. From the OIU, an operator may select either grit washer no.1 or no.2 to operate with both grit collectors. In this mode, the grit washer would initiate the washing cycle until the grit pump run signal is removed. A delay shall occur before the grit pump associated with the alternate grit collector is started. The grit collector, grit pump, stirrer, grit screw, organics valve, and wash water will stop immediately, and the control power on light will be de-energized if any of the e-stop pushbuttons are pressed. Once the pushbuttons are reset, the system reset pushbutton must be pressed before the equipment will cycle.
 - z. If power to the panel is interrupted, the equipment may cycle after a 5 second power up delay once the power is restored, without pressing the system reset pushbutton.
3. Each Grit Collector shall be provided with a NEMA 7, Cast Aluminum Local Control Station. Each Local Control Station Shall be equipped with the following devices
- a. Hand-Off-Auto selector switches for the following
 - 1) Horizontal Grit Auger drive
 - b. Grit Washer forward-off-reverse
 - c. Grit Auger drive E-stop pushbutton (red)
 - d. When the grit collector selector is in the hand position, the grit collector will run continuously.
 - e. When the grit collector selector is in the auto position, the grit collector will cycle off and on, off time first, per the grit collector repeat cycle timer.
 - f. The grit collector will start operating per the off and on cycle timer, once the feed pump running signal has been received.
4. Each grit pump shall be connected to the local control panel and shall be equipped with the following modes of operation:
- a. When the grit pump selector is in the hand position, the grit pump will run continuously.

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- b. When the grit pump selector is in the auto position, the grit pump will start running for the time set in the grit pump on time before collector timer, before the grit collector has been called to run. The grit pump will continue to run after the grit collector shuts down for the time set on the grit pump off delay timer.

5. Faults:

- a. When the grit collector motor overload is tripped, the grit collector will stop immediately and the grit collector fault light will energize.
- b. When the grit collector current monitor senses high current, the grit collector will stop immediately and the grit collector fault light will energize.
- c. When the grit pump motor overload is tripped, the grit pump will stop immediately and the grit pump fault light will energize.
- d. When the stirrer motor overload is tripped the stirrer and grit auger will stop immediately, the organics valve will close, and the stirrer fault light will be energized.
- e. If high current is measured, the stirrer and grit auger will stop immediately, the organics valve will close, and the stirrer fault light will be energized.
- f. When the grit auger motor overload is tripped the stirrer and grit auger will stop immediately, the organics valve will close, and the grit auger fault light will be energized.
- g. If high current is measured, the stirrer and grit auger will stop immediately, the organics valve will close, and the grit auger fault light will be energized.
- h. If the organics valve is called to close and does not reach the closed position within the time set in the organics valve fault timer, the stirrer and grit auger will stop immediately and the organics valve fault light will be energized.
- i. If the organics valve is called to open and does not reach the open position within the time set in the organics valve fault timer, the stirrer and grit auger will stop immediately and the organics valve fault light will be energized.
- j. All of the above faults can be reset by pressing the system reset pushbutton.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Contractor shall install complete equipment in accordance with Manufacturer's instructions and as indicated and specified. Support frame and lamella trays shall be assembled on site by Contractor before installation into concrete channel.
- B. After installation touch-up paint shall be applied to all scratched, abraded, and damaged shop painted surfaces. Coating type and color shall match shop painting. Contractor shall not perform field welding of stainless steel.

3.2 PERFORMANCE TESTING

- A. **Refer to** Section 11414 – Grit Removal Performance Testing for details.

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3.3 WARRANTY

- A. The manufacturer will warrant against any defects in material or workmanship to the grit removal system. This warranty will commence upon delivery of the products and will expire two years following Substantial Completion. In addition, the manufacturer shall provide a ten (10) year warranty on the horizontal grit auger liner for the grit collectors.
- B. The manufacturer shall provide a service contract for the first ten (10) years after installation of the GritWolf(s), including:
 - 1. Semi-annual trips per year, including one to two days on site
 - 2. All required maintenance parts over the ten-year period
 - 3. **Services shall include inspection of each GritWolf auger liner and replacement as needed over the service contract or at the end of the ten (10) year period.**
- C. The site shall be a reference site for future HUBER Technology customers. For each customer sent on site, a \$500 voucher will be provided to the City of Ann Arbor WWTP and can be used for GritWolf spare parts or additional service trips/days by HUBER certified service technician.

3.4 MANUFACTURER'S FIELD SERVICE

- A. Start-up and Operator Training: Manufacturer's Service Engineer for the equipment specified herein shall be present at the jobsite for two (2) trips and eight (8) man-days, travel time excluded, for installation assistance, functional testing, certificate of the installation, and Operator training. Service Engineer must have a minimum of five (5) years of experience on the type and size of equipment specified. Manufacturer's Service Engineer shall inspect location of anchor bolts; check setting, leveling, alignment, field erection. Manufacturer's Service Engineer shall calibrate and start-up the equipment.

END OF SECTION

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SECTION 11414

GRIT REMOVAL PERFORMANCE TESTING

PART 1 -- GENERAL

1.1 SUMMARY OF WORK

- A. The performance test is in addition to the normal mechanical testing and adjustments required for attaining equipment acceptance. The cost for the testing shall be paid for by the Contractor. The testing shall be as described below.
- B. Performance testing of the grit collectors and grit washers shall not begin until proper startup of equipment completed by the manufacturer has occurred and after the successful completion of a 7-day demonstration period (min.). The demonstration period shall be continuous days and without the need for equipment repair or modifications during that period.
- C. All grit collectors and grit washers installed under this contract shall be tested by Black Dog Analytical (Grit Removal Performance Testing Contractor) or approved equal third-party company specializing in grit performance testing and characterization, under contract with the Contractor. All labor, materials, tools, equipment and supervision required to successfully complete the equipment performance testing will be provided by Grit Removal Performance Testing Contractor.
- D. Penalty details if the Grit Collector and Grit Washer do not perform as anticipated are listed within this specification.

1.2 ITEMS SPECIFIED ELSEWHERE

- A. Section 01300 – Submittals including Shop Drawings
- B. Section 11112 – Horizontal Recessed Impeller Pumps
- C. Section 11413 – Grit Removal System & Washer

1.3 SYSTEM DESCRIPTION

- A. The equipment tested includes the following:
 - 1. The grit collector shall include the following components:
 - a. Lamella trays and support frame within existing North and South Grit Chambers
 - b. Lower horizontal shafted grit screw with trough liner, drive motor and gearbox assembly
 - c. Grit slurry pump
 - d. Controls and appurtenances. Control panel shall include necessary starters and breakers for equipment for each grit removal system.
 - 2. The grit washer shall include the following components:
 - a. Grit washer tank installed within Dumpster Room

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- b. Central inlet vortex chamber
- c. Coanda tulip for directing inflowing grit slurry in radial direction to a circumferential overflow weir
- d. Conical stratification tank with cover
- e. Stirring device with gear motor
- f. Fluidized grit bed at the bottom of the stratification tank for intensive grit washing and separation of particles dependent on their specific gravity difference
- g. Grit conveying and dewatering screw
- h. Controls and appurtenances

PART 2 – NOT INCLUDED

PART 3 -- EXECUTION

3.1 GENERAL

- A. Contractor shall submit detailed performance testing plan including sampling procedures and data analysis techniques for approval by the Engineer prior to commencing performance testing of equipment.
- B. Contractor shall install Grit Collector and Grit Washer equipment in accordance with Manufacturer's recommendation and perform all work included in Headworks Improvements.
- C. Testing phase described shall not begin until proper startup of equipment completed by the manufacturer has occurred and after the successful completion of a 7-day demonstration period (min.). The demonstration period shall be continuous days and without the need for equipment repair or modifications during that period.
- D. Manufacturer shall guarantee and demonstrate that the grit collector(s) and grit washer(s) supplied shall meet the performance requirements specified in Section 11413 and herein.
- E. The following physical conditions shall be demonstrated by each grit collector and grit washer unit installed:
 - 1. Operate reliably without breakdown or stoppage at all design conditions.
 - 2. Require minimal operation and maintenance.
 - 3. Grit washer shall accept pumped design flow.
 - 4. Performance data will not be evaluated on a combined average of all units tested.
 - 5. Each unit must meet the design requirements.

3.2 GRIT COLLECTOR PERFORMANCE TESTING

- A. Testing Methods and Materials
 - 1. Sampling locations shall be chosen by Grit Removal Performance Testing Contractor, both upstream and downstream of the grit removal equipment.
 - 2. Obtaining a grit sample can be affected by many variables such as weather, upstream system, etc. and affects the grit coming to the plant. Procedures shall account for these variables and fluctuations.

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3. Grit Removal Performance Testing Contractor shall provide all equipment to complete testing.
4. Grit Removal Performance Testing Contractor shall provide a report with grit particle size distribution, organic content collection by grit removal technology and flow measurements over effluent weir or by flow measurement device.
5. Representatives of the Engineer will observe the tests and collect a copy of the recorded data. The information collected will be used as a basis for determining acceptability of the Grit Removal Performance Testing Contractor's results. In case of conflict, interpretations and calculations made by the Engineer will govern. The initial observation of tests will be at the Owner's expense. All costs of subsequent visits by the Engineer to witness or observe additional tests necessary because of failure of the initial tests or inability to conduct tests will be at the expense of the Equipment Supplier.
6. The data to be determined shall include but not be limited to:
 - a. Size classification of the grit in the influent to the grit collector.
 - b. Size classification of the grit in the effluent from the grit collector.
 - c. Size classification of the grit in the underflow from the grit collector.
 - d. Percent removal of the various grit fractions.
 - e. Flow measurements over grit collector effluent weir or by alternate flow measurement device agreed upon by Engineer.
 - f. Additional data as necessary to determine compliance with the specifications.
7. Performance Test Procedures
 - a. The Grit Removal Performance Testing Contractor shall submit detailed testing procedures specific to this installation a minimum of two weeks prior to the performance test.
 - b. The Grit Removal Performance Testing Contractor shall perform two (2) performance tests of four-hour duration under approximately steady-state conditions.
 - c. Tests will be conducted with plant influent flow at average flow rates ranging from 10 mgd to 18.5 mgd per grit collector. The flow shall be monitored and recorded throughout the test period. The plant influent flow shall be measured by the existing plant influent flow measuring devices.
 - d. Tests will be conducted for a 8-hour interval. The grit collector effluent and influent will be continuously sampled during the entire test interval. At the end of each 8-hour test interval the sampling will stop.
8. Samples will be taken at the following points:
 - a. Grit collector influent
 - b. Grit collector effluent
9. Sampling of the grit collector influent will be done with an isokinetic vertically integrated sampler. Sampling of the grit collector effluent shall be done by collecting the sample as it passes over the weir.
10. The samples shall continuously flow into a settling basin with an overflow of no more than 3.2 gpm per square foot of surface area. This insures capture of all 100 micron particles and greater, 2.65 S.G. particles in the effluent sample. At the end of the test interval allow a quiescent settling period (2.3 minutes per foot of basin depth) and then decant the basin. Collect the settled solids for particle size analysis.
11. The samples will be composited for the laboratory testing and evaluated according to Standard Method procedures. Samples shall be evaluated at an outside test facility approved by the owner/engineer.

12. The settled solids will be collected for SES particle size analysis for wet sieve analysis. The percent grit removal of grit particle sizes of 50, 75, and 100 micron shall be determined from SES and sieve analysis data collected by the test procedures on each of the three samples taken concurrently at the effluent sampling points.
 13. Sampling of the dewatered grit will be to collect all dewatered grit during each 4 hour test period for solids analysis and amount removed. Multiple dewatered grit samples from the grit pile generated by each 4 hour test period will be composited for laboratory testing and evaluated according to Standard Method procedures. Samples shall be processed at an outside test facility mutually approved by the Equipment Supplier, owner and engineer.
 14. Laboratory testing of the two dewatered grit samples will include wet sieve analysis of the settled solids (50, 75, 100, 150, 200, 270 mesh). Measurement of the solids retained on each sieve including pan dry weights before and after muffle furnace burning of the organics. This data will be used to determine Total Solids (TS), Volatile Solids (VS), and Fixed Solids (FS). The analytical methods for the solids analysis are:
 - a. Water Content of Wet Solids per ASTM D2216
 - b. Total Solids per Standard Methods 2540B
 - c. Volatile Solids per Standard Methods 2540E
 - d. Sand Equivalent Size (SES)
 15. The Grit Removal Performance Testing Contractor shall prepare a final report summarizing all test data and results. The report shall include the grit removal efficiency of the grit collector based on the amounts and size distribution of grit collected in the sampling containers. Dewatering grit from the grit pile in the dumpster shall be analyzed for size distribution of grit collected. The report shall also document the influent flow per grit collector for the entire testing period.
 16. The test results and observations shall be submitted for approval and acceptance by OWNER.
- B. Grit Collector must meet the following criteria specified by manufacturer;
1. Peak Conditions:
 - a. Grit Removal Efficiency between 18.5 MGD and 30 MGD, 95 % \geq 212 micron
 2. Average Conditions:
 - a. Grit Removal Efficiency between 10.5 MGD and 18.5 MGD, 95 % \geq 125 micron

3.3 GRIT WASHER PERFORMANCE TESTING

- A. Contractor shall furnish labor for each sample collection and shall pay cost of laboratory analysis as specified herein, unless otherwise negotiated with owner. Samples shall be processed by an outside test facility proposed by the contractor and mutually approved by the owner and engineer.
- B. Testing Methods and Materials
1. As a requirement of this specification the manufacturer shall demonstrate that the grit washer(s) conform with the performance and operating criteria specified herein and the following tests shall be conducted at site on each operating grit washer unit:
 - a. Contractor shall provide clamp on type flow meter and shall be attached to grit delivery pipe from the grit pump and after calibration, flow readings shall

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- be taken for a minimum three pumping cycles, or over one-half hour of continuous run time, to demonstrate the grit washer is operating at the specified flow.
- b. Grit material discharged from the grit washer unit(s) shall be analyzed for organic content and moisture content. The organic content and moisture tests shall take place over a two-week period. Plant staff shall take three (3) random 2-cup samples taken any 3 days within a consecutive two-week period for a total of 9 samples. Samples shall be taken immediately upon discharge from each washer, sealed in a vapor tight container and sent out for testing the same day.
- c. The test results and observations shall be submitted for approval and acceptance by OWNER.

3.4 COMPLIANCE

1. If the grit removal equipment fails to satisfy the specified grit removal performance requirements, the equipment shall be modified as required to produce an installation that will satisfy the requirements. The equipment shall be completely retested after modification. Modifications shall be provided, and retesting shall be performed at no additional cost to the Owner. All modifications, including structural or electrical modifications, necessary to accommodate the modified equipment shall be made at no additional cost to the Owner.
 - a. If the modified system does not meet the required performance parameters after two (2) additional performance tests, then the Owner's representative may:
 - b. Allow the Equipment Supplier to make additional changes, and run additional performance tests at no additional cost to the Owner, or
 - c. The OWNER will modify the contract cost or reject the grit collector or grit washing equipment as a whole based on the actual performance of the equipment as stated below. This charge shall be calculated for average conditions. Only one charge shall be assessed.
2. Grit Collector: Grit removal of ≥ 125 micron at average flow conditions
 - a. 95 % or greater – 100%
 - b. Greater than 90% but less than 95% - 95% payment
 - c. Greater than 85% but less than 90% - 90% payment
 - d. Less than 85%, equipment will be rejected, and manufacturer shall reimburse owner of all costs for providing and installing grit collector equipment.
3. Grit Washer: Organics content
 - a. 5% or less- 100% payment
 - b. Greater than 5% but less than 7.5% - 95% payment
 - c. Greater than 7.5% but less than 10% - 90% payment
 - d. Greater than 10%, equipment will be rejected and manufacturer shall reimburse owner of all costs for providing and installing grit washing equipment.
4. Grit Washer: Moisture content
 - a. 10% or less – 100%
 - b. Greater than 10%, but less than 20% - 95% payment
 - c. Greater than 20%, but less than 30% - 90% payment

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- d. Greater than 30%, equipment will be rejected and manufacturer shall reimburse owner of all costs for providing and installing grit washing equipment.
- 5. Owner and/or owners' representative shall be present for test.

END OF SECTION

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SECTION 13253

ACTIVATED CARBON ODOR CONTROL SYSTEM

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Odor Control System Supplier (OC Supplier) shall furnish all equipment and appurtenances required to install (by the Contractor), test, and place into operation an activated carbon odor control system (System) for the control of atmospheric hydrogen sulfide (H₂S), reduced sulfur compounds, and other wastewater-related odors as shown on the Drawings and as specified herein. The System shall be a pre-engineered, dual deep bed adsorption system consisting of two FRP adsorption vessels with media, media support systems, inlet grease filters/mist eliminators (GFMEs), fans, Fan Control Panels, instrumentation, vessel ladder and safety rail system, and all other appurtenances required for a complete operating system.
- B. An activated carbon odor control system shall be provided with two equally-sized trains (GFMEs, fans, vessels, and ductwork) rated for 8,000 cfm each, for a total system capacity of 16,000 cfm, as shown.
- C. All equipment located within three (3) feet of any component of System that is under positive pressure including – but not limited to the ductwork, exhaust fans, and vessels – shall be suitable for NEC Class I, Division 2, Group D environment.
- D. All materials and equipment furnished under this section, whether shown on the Drawings or not, are to conform to the material requirements specified herein or in other Specification sections, whether specifically noted or not. Applicable installation and testing requirements specified in other sections shall apply to materials and equipment furnished under this section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Specifications:
 - 1. Division 1, General Requirements
 - 2. Division 5, Metals
 - 3. Division 9, Finishes
 - 4. Division 11, Equipment
 - 5. Division 15, Process Interconnections
 - 6. Division 16, Electrical
- B. U.S. Department of Commerce Voluntary Product Standard PS-15-69
- C. ASTM C581 – Chemical Resistance of Thermosetting Resins used in Glass Fiber Reinforced Structures

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- D. ASTM C582 – Reinforced Plastic Laminates for Self-Supporting Structures in a Chemical Environment
- E. ASTM D3299 – Filament Wound Reinforced Polyester Chemical-Resistant Tanks
- F. ASTM D4097 – Contact Molded Glass Fiber Reinforced Thermoset Resin Chemical-Resistant Tanks
- G. ASTM D 4167-16 – Standard Specification for Fiber-Reinforced Plastic Fans and Blowers
- H. ASTM D 2996 – Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced-Thermosetting-Resin) Pipe
- I. ASTM D 3982 – Contact Molded “Fiberglass” (Glass Fiber Reinforced Thermosetting Resin) Duct and Hoods

1.3 SUBMITTALS

- A. In addition to the submittal requirements specified in Section 01300 – Submittals, and Section 15000, Equipment, General, submit the following:
 - 1. Performance Affidavit, Guarantee, and Warranty.
 - 2. Operation and Maintenance Manual conforming to Section 01730, Operation and Maintenance Data.
 - 3. Identification of recommended operating speeds
 - 4. OC Supplier’s literature, illustrations, specifications, and engineering data including dimensions, materials, size and weight of all components and complete operating assembly.
 - 5. Complete erection, installation, and adjustment instructions and recommendations.
 - 6. Drawings showing plans and sections of the equipment to demonstrate proper coordination between components, fabrication methods, assembly and accessories.
 - 7. Complete design calculations shall be provided for vessels, media support system, anchorage systems, and ladder/safety rail system to show compliance with the Building Code, as well applicable OSHA requirements, sealed by a Registered Professional Engineer in the State of Michigan.
 - 8. Certification of safety rail system compliance with ASTM and OSHA Standards.
 - 9. Media specification sheet.
 - 10. Grounding certification.
 - 11. Testing procedures and results and H₂S analyzer calibration certificates.
 - 12. Anchor and tie-down system design calculations signed and sealed by a Registered Professional Engineer in the State of Michigan. Shall include, but not be limited to, anchor calculations for design of fastening system to concrete pad to withstand applicable wind load criteria and other loadings discussed herein. Shall include size, embedment, and installation design criteria for anchor bolts and tie downs.
 - 13. Written instructions as to the recommended methods for unloading, storing, and installing the fiberglass vessel and activated carbon media, as well as recommended handling procedures.
 - 14. A description of the proposed quality control program that will be used during the manufacturing of the System. Include the resume of the quality control manager.

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15. Submit factory test certifications indicating the quality control, testing, and inspection has been completed and standards specified herein have been met prior to shipment to the jobsite.
 16. Performance testing plan and report.
 17. If not a Supplier listed in Part 2.01.A, provide satisfactory installation list of five systems of the same type as specified, with a minimum of 15,000 cfm and a minimum of five years in service. Submit design criteria information (cfm, H₂S inlet concentration, % removal, and vessel dimensions), location, and contact references (including name, job title, locations, phone number, email address, and start-up date) for the installed systems submitted to the Engineer.
 18. Complete electrical schematic wiring diagram drawings and process and instrumentation diagrams.
 19. Literature showing the electrical rating, model and manufacturer for all major electrical components.
 20. List of recommended spare parts.
 21. In addition, the following data for motors shall be provided:
 - a. Motors
 - b. Name and manufacturer
 - c. Type and model
 - d. Bearing type and lubrication
 - e. Horsepower rating and service factor
 - f. Temperature rating
 - g. Full load rotative speed
 - h. Net weight
 - i. Efficiency at rated load
 - j. Full load current
 - k. Overall dimensions
- B. OC Supplier's representative shall provide Certificate of Proper Installation (CPI) after installation and testing is complete.

1.4 SUPPLIER'S RESPONSIBILITY

- A. The OC Supplier shall be responsible for coordination of the design and fabrication of the odor control System specified herein and as shown on the Drawings.
- B. The OC Supplier shall coordinate and review installation procedures under other Sections and coordinate the installation of items that must be installed to comply with the requirements of the Work specified under this Section.
- C. The services of the OC Supplier's representative shall be provided in accordance with Section 01650, Equipment Start-up, Demonstration, and Facility Commissioning and Section 15000, Equipment, General for a period of not less than eight (8) days as follows:
 1. At least one (1) trip of two (2) days to supervise and check the installation of the System (including media) and supervise initial start-up and operation.
 2. One (1) trip of two (2) days to perform System performance testing.
 3. One (1) trip of two (2) days to instruct the Owner's personnel in proper operation and maintenance of the equipment.
 4. One (1) trip of two (2) days for a return visit after a period of six (6) months to re-perform System performance testing.

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- D. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.
- E. A written report covering the representative's findings and installation approval shall be submitted to the Engineer covering all inspection and outlining in detail any deficiencies noted. Written report shall state that the equipment has been properly installed and tested to the manufacturer's satisfaction and that all required final adjustments have been made.
- F. The times specified are exclusive of travel time to and from the facility and shall not be construed as to relieve the OC Supplier of any additional visits to provide sufficient service to place the equipment in satisfactory operation.
- G. The OC Supplier and the Contractor shall be responsible for any license fees that may apply to this system.

1.5 QUALITY ASSURANCE

- A. All components of the odor control System shall be supplied by a single OC Supplier fully experienced, reputable, and qualified in the manufacture of the equipment to be furnished.
- B. OC Supplier shall have at least five (5) years' experience in the design and fabrication of the specified odor control system and shall, at the Engineer's request, provide a list of at least five (5) successful installations operating for a minimum of three (3) years of comparable size (greater than or equal to 15,000 cfm) and application, with references including valid current contact names and phone numbers.

1.6 WARRANTY

- A. All odor control System mechanical components shall be warranted with a 2-year Warranty against defects in workmanship and materials that shall begin once the unit has been started and is meeting all performance requirements and has been accepted by the Owner.

PART 2 -- MATERIALS

2.1 ACCEPTABLE SUPPLIERS

- A. The OC Supplier shall be responsible for the coordination of all equipment specified herein. The odor control System shall be a dual deep bed activated carbon adsorber supplied from one of the following:
 - 1. ECS Environmental.
 - 2. Daniel Company.
 - 3. Or approved equal.
- B. The materials covered by these Specifications are intended to be standard equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Contract Drawings and operated per OC Supplier recommendations.

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2.2 OVERALL SYSTEM REQUIREMENTS

- A. The odor control System shall consist of the principal components listed below along with any associated appurtenances required for a complete and operational system:
1. Two (2) cylindrically-shaped, insulated, dual deep bed FRP carbon vessels.
 2. Activated carbon media.
 3. Two (2) grease filter/mist eliminators (GFMEs).
 4. Two (2) FRP fans.
 5. Two (2) variable frequency drives (VFDs) each housed in the dedicated vendor-provided Fan Control Panel.
 6. All FRP duct, expansion joints, dampers, duct supports, inlet transition pieces, and exhaust stacks from the GFME outlet to the adsorption System exhaust stacks.
 7. Hydrogen sulfide carbon saturation indicators with associated ports.
 8. Carbon media sampling ports.
 9. Inlet and exhaust airflow sampling taps.
 10. Vessel ladder and safety rail systems.
 11. Equipment, instrumentation, stainless steel instrument tubing, instrumentation and controls, and System Control Panel as shown and specified to properly operate and monitor the odor control System and fan.

B. The OC Supplier shall identify in their equipment submittal, any additional and/or changes to equipment, electrical components, and instrumentation components that are required to meet the Contract Documents.

C. All materials shall be new and suitable for the service to which they are subjected.

D. Sizes and capacities of equipment components specified shall be understood to establish minimum requirements only and do not relieve the equipment supplier of responsibility for providing a properly functioning system.

E. The odor control System shall be capable of removing hydrogen sulfide, reduced sulfur compounds, and other wastewater-related odors from the foul air stream by adsorption to the carbon media using a dual deep bed adsorber configuration. The foul air shall enter the system in the middle of the vessel and the foul air shall flow upwards and downwards through the two media layers for treatment prior to exiting the top of the vessel through two dedicated stacks.

F. The System shall perform in accordance with the design basis. It shall be designed for continuous operation in a highly corrosive environment.

G. Operating Conditions (per train):

Number of Units	2
Type	Dual Deep Bed
Vessel Diameter (feet)	10
Vessel Height, Straight Shell Maximum (feet)	12
Air Flow Rate, Minimum (scfm)	8,000
Carbon Volume, Minimum (ft ³)	470
Minimum Empty Bed Contact Time (EBCT), seconds	3.5
Media Depth, Minimum Per Layer (feet)	3.0
Vessel Air Velocity, Maximum (fpm)	60

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Inlet H ₂ S Concentration, Average (ppm)	3.5
Inlet Reduced Sulfur Compounds, Average (ppm)	0.15
H ₂ S Removal Efficiency, Minimum (%)	99.0
System Pressure Drop, Maximum (inches W.C.)	5
Upstream Pressure Drop, Maximum (inches W.C.)	5
Vessel Drain Connection Size, Maximum (inches)	2
Number of Exhaust Fans (per train)	1 Duty
Exhaust Fan Design Capacity, Each (scfm)	8,000
Maximum Motor Horsepower (hp)	20
Maximum Motor Speed (rpm)	2,500
Drive	Variable, Belt
Inlet Mist Eliminator	Yes

2.3 VESSEL CONSTRUCTION

- A. The vessel shall be designed using a minimum structural safety factor of 10 to 1 for pressure and 5 to 1 for vacuum. The vessel shall have bottom knuckle reinforcement and be designed for hydrostatic head load 8 feet above the top of the inlet.
- B. Vessel housing shall be designed for full bottom support and shall be provided with a minimum of six (6) Type 316 stainless steel hold down lugs. All hold down lugs shall be designed to account for all anticipated loads and shall comply with local code requirements. Furnish all anchor bolts, nuts, and washers which shall be Type 316 stainless steel.
- C. The odor control system shall be manufactured of FRP in accordance with these specifications. All integrally molded connections shall be manufactured of the same material.
- D. The adsorber vessel shall be designed and constructed from fiberglass reinforced plastic (FRP) materials with ample structural strength and rigidity for the service required. All integrally molded connections shall be manufactured of the same material. All materials of construction shall be corrosion resistant based on the environment in which they will operate.
- E. Insulation: Vessel sidewall and top shall have a factory-applied insulation system to prevent internal condensation. Condensation barrier should consist of 2" foam board insulation applied to the vessel exterior with a secondary ¼" thick FRP skin to encapsulate and protect the foam. Total R value shall be 14 or greater.
- F. Provide a non-skid surface on the top of each vessel.
- G. Fiberglass Reinforced Plastic (FRP) Vessel Construction:
 - 1. Vessels shall be Filament-Wound in accordance with ASTM D3299-88, Grade 1. Portions of the vessel, including joints and duct connections shall be fabricated by contact molding. Contact molded laminates shall be in accordance with ASTM C582, Table 1.
 - a. Vessel wall thickness shall be as required by structural design but not less than ¼ inch. Laminate physical properties for laminate thickness of 3/8 inch and thicker shall be as follows:
 - b. Resins used in laminate shall be premium corrosion resistant and fire-retardant brominated bisphenol A vinylester resins to achieve a 25 or less flame spread rating in accordance with NFPA 91.

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- 1) Resin shall be Hetron FR992 or FR992SB, as manufactured by Ashland Chemical Company, DeraKane 510A, as manufactured by Dow Chemical Company, Dion 9300 FR, as manufactured by Reichold, Vipel K022-CC or K022-CN, as manufactured by AOC, or approved equal.
- 2) Antimony trioxide may be added to the structural layer, if required to obtain the required Class 1 flame spread rating of 25 or less.
- 3) Antimony trioxide addition shall not exceed 3% and shall not be added to the interior liner of the vessel.
- 4) Selected resin shall be used for fabrication throughout the entire vessel. Use of more than one resin during fabrication is not acceptable.
- 5) No dyes, pigments or colorants shall be used except in the exterior coat.
- 6) The resin shall not contain fillers or thixotropic agents unless otherwise specified.
- c. Ultraviolet absorbers shall be added to the surfacing resin to improve weather/UV resistance of the vessel. No fillers or thixotropic agents shall be added. Exterior coating shall not be applied until after inspection of the laminate has been completed.
- d. All cut edges shall be sealed with a resin coating of the same resin as used in the fabrication. The resin shall contain paraffin.
2. Curing System: Vessel shall be cured using a MEKP procedure and in accordance with the recommendations of the resin manufacturer, including post cure temperatures and times. Provide letter from the resin manufacturer, stating that the resin will meet the performance requirements stated herein, that the resin is suitable for the service conditions specified herein and fabrication technique proposed and recommended post-cure method.
3. Reinforcement:
 - a. Synthetic surface veil shall be Veil-Nexus 1012 (apertured) as manufactured by either Burlington Industries or Precision Fabrics Group.
 - b. Chopped strand mat shall be Type E glass, minimum 1-1/2 ounces per square foot, with silane finish and styrene-soluble binder.
 - c. Continuous roving used in chopped gun shall be Type E glass.
 - d. Woven roving shall be Type E glass, nominal 24 ounces per square yard, with a 4 by 5 weave and a silane-type finish.
 - e. Continuous roving used for filament winding shall be Type E glass, nominal 110 strand yards per pound, with a silane type finish.
4. Laminates:
 - a. Laminates shall consist of a corrosion-resistant resin-rich inner surface, an interior corrosion barrier, an exterior structural layer and an exterior layer. Composition specified for inner surface and interior corrosion barrier is intended to achieve optimum chemical resistance.
 - b. Corrosion-resistant resin-rich inner surface shall be reinforced using a single apertured Nexus synthetic veil. Minimum resin-rich inner surface thickness shall be 10-20 mils. Thixotropic agents shall not be used for this service. Glass content of resin-rich inner surface shall be 10 percent plus or minus 5 percent by weight. Resin content of the inner surface shall be a minimum of 80 percent by weight.

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- c. Interior corrosion barrier shall be a minimum of 100 mils of Type E chopped strand mat to a total of 3 oz/sq. ft. The interior corrosion barrier shall be applied by either the hand laid up technique, filament winding or chopper gun. Chopper gun is only permitted if an automated process is used. Manual operation of chopper gun shall not be permitted. Glass content of interior corrosion barrier shall be 27 percent plus or minus 5 percent by weight.
- d. Exterior structural layer shall be fabricated using a filament wound technique with continuous strand roving. Glass content of exterior structural layer shall be between 50 and 80 percent by weight.
- e. Exterior layer shall be reinforced using a single "A" glass veil with a layer of chopped strand mat followed by a clear followed by a clear resin rich 10 mil thick coating similar to the inner surface. Topcoat shall be pigmented parafinated gel-coat with ultraviolet inhibitors. The pigmentation shall be colored as selected by the Owner. There shall be no glass fibers exposed.
- f. Vessel wall shall be reinforced around all openings and connections.

2.4 ACTIVATED CARBON ADSORBER SYSTEM

- A. The adsorption vessel design shall be capable of processing odorous air at such a velocity that the empty bed contact time (EBCT) across the activated carbon bed shall not be less than the value specified above.
- B. Carbon Support System: The support system for the carbon bed shall be as recommended by the odor control vessels supplier and approved by the Engineer. The carbon bed shall be supported by a polypropylene screen basket resting on a support system. The carbon bed screen and support system shall be removable through access manways. The support system shall be a system capable of withstanding a load of not less than 300 pounds/square foot with a deflection not greater than 1/4-inch under any operating condition. All components of the support system shall be constructed of materials resistant to the chemical service conditions specified for corrosion. Pall rings or dump packing shall not be used to support the carbon beds.
- C. Carbon Basket: A fully seamed polypropylene screen sewn basket shall be provided to hold the activated carbon without fraying. All edges and seams shall have "piping" to reinforce the seams and edges to prevent fraying. The basket shall be of sufficient strength to hold the carbon without tearing. The finished product shall have a minimum of 50% free area.
- D. Carbon adsorber vessels shall be provided with vessel top access including ladder and safety rails, supported off the FRP vessel, for media replacement and all other required maintenance activities. The platform and safety rails shall be designed in accordance with all applicable building codes and OSHA standards.
- E. Vessels shall be constructed and rated for foot traffic for maintenance purposes on the top of the vessel. The carbon adsorber vessel top shall also be appropriately constructed to support the exhaust stacks as detailed herein and shown on the Contract Drawings.
- F. Carbon adsorber vessels shall have a minimum of two (2) rectangular top-mounted manways and four (4) side mounted manways, two (2) per media layer, located 180 degrees apart and sized 30-inch diameter or greater, for ease of carbon replacement and internal inspection.

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2.5 ODOR CONTROL SYSTEM ACCESSORIES

- A. All necessary connections for piping, instrumentation, sampling, and ductwork shall be provided as shown on the Drawings or required. Suitable EPDM gaskets shall be provided where required. The OC Supplier shall provide the following appurtenances with the vessel:
1. Schedule 80 drain assembly with CPVC ball valve, sized as specified in Paragraph 2.02 G above.
 2. Six (6) carbon sample probes, 1.5-inch, extending a minimum of 6 inches into the carbon bed. Probe shall be adequate to provide suitable extraction of carbon samples from the carbon bed and be non-binding. Probes shall extend outside the vessel wall and be blocked off with ball valves. Three probes shall be spaced at even intervals throughout each media bed. Probes and ball valves shall be constructed of Schedule 80 CPVC.
 3. Three (3) air sample ports: 2-inch diameter. One (1) air sample port shall be located on the System inlet duct, and two (2) air sample ports shall be located on the exhaust – one (1) for each bed exhaust stack. Vertical exhaust stack sample port shall be provided with a down-turned 2-inch diameter tap, routed down to approximately 4-ft above the finished grade, with a 2-inch ball valve.
 4. Two (2) 0.5-inch taps for differential pressure switches/gauges – one (1) for each media bed.
 5. OC Supplier shall provide factory-mounted Type 316 stainless steel pipe supports for outlet air sample ports, bottom drain connection, and overflow piping.
 6. Flanges for air inlet and outlet shall be manufactured by hand lay-up method and shall conform to NBS-PS 15-69, standard dimensions for bolting, but in no case shall the thickness be less than 3/4-inch thick. Flange nozzles for piping connections shall conform to ASTM D 3299, all nozzles up to and including 8-inch diameter shall be reinforced with blade type gussets. Flanges for piping connections shall be ANSI 150-lb dimensions. All flanges shall be pre-drilled. Flanges shall be checked for alignment, thickness and mating prior to shipment to field. Area on the back of all flanges around each bolt hole shall be the diameter of a standard washer and shall be flat and parallel to flange face. This area shall be spot faced, if necessary, to meet this requirement.
- B. Ladder and Safety Rail System: The carbon adsorber shall be provided with a fiberglass reinforced plastic (FRP) safety rail around the top of the vessel. FRP ladder and safety rail system shall be designed by the vessel manufacturer to meet or exceed OSHA requirements with a minimum safety factor equal to 2. Safety rail systems shall consist of all railings, posts, toeboards, base plates, fasteners, and necessary appurtenances for a complete and rigid installation shall be provided and installed per manufacturer's recommendations. The safety rail system shall have two (2) rails, with the top rail located 42 inches above the walking surface. Maximum horizontal spacing between posts shall be 4 feet. Safety rails shall be erected with true horizontal and vertical alignment and shall be smooth and free of surface defects. Toeboards shall be provided in accordance with Section 06110, Glass Fiber and Resin Fabrications. All cut edges and holes shall be sealed with a compatible resin system. The opening of the safety rail system shall be coordinated with the ladder as shown on the Contract Drawings. Coordination of the access location is the responsibility of the Contractor and OC Supplier.
- C. Grounding System: Vessel grounding system, including but not limited to a 3/8-inch diameter Type 316 stainless steel grounding rod, shall be provided, subject to Engineer's approval, and

shall penetrate a minimum of 30-inches into each media bed. OC Supplier shall supply adequate details to demonstrate that the carbon bed will be adequately electrically grounded. OC Supplier to provide grounding certification submitted with shop drawings.

- D. Lifting Lugs: Lifting lugs shall be capable of withstanding weight of the empty vessel with a minimum safety factor of 5 to 1. A minimum of three lugs shall be furnished per vessel. Lifting lugs shall be Type 316 stainless steel or FRP and attached to the vessel wall with hand lay-up laminate equal to or greater than the vessel wall thickness.
- E. Inlet Transition Piece: OC Supplier shall provide a transition piece for connecting the flanged air inlet on the carbon vessel to the inlet FRP ductwork: NBS PS 15-69 flanged nozzle air inlet. Vessel inlet shall have a maximum face velocity of 1,800 fpm and inlet invert elevation shall be a minimum of 9-inch above the lower media layer surface.
- F. Hydrogen Sulfide Monitor: Each system shall be furnished with two (2) hydrogen sulfide monitors, per carbon bed, capable of visual detection of H₂S breakthrough. The monitors shall be mounted at two (2) locations equally spaced throughout each carbon bed. The monitors shall have replaceable tubes. The monitors shall have a fitting to attach to any carbon bed sampling port.
- G. Duct Supports: The OC Supplier shall be responsible for the design of all duct supports furnished for the ductwork specified under Part 2.10, below. Duct support details and layout shall be submitted in the shop drawings. Proposed duct supports shall be in accordance with the Drawings and shall comply with Section 15060, Exposed Process Pipe and Fittings.
- H. Carbon Sampling Device: One grain thief sampling device shall be provided for each odor control unit. The device shall be a Fisher Scientific Model 14-208Q, or equal.
- I. Rain Guard: Two (2) FRP “no loss” high dispersion discharge stacks, factory installed. Plain end reducer/nozzle outlet with SMACNA no loss dispersion stack: size as shown on Drawings.
- J. Expansion Joint: As shown on the Drawings, provide in accordance with Section 15600 – Ductwork Accessories.

2.6 ACTIVATED CARBON

- A. Sufficient activated carbon shall be provided to fill the vessel to the height of the vessel. The Contractor shall re-examine the media levels prior to startup and testing and add additional media as required to compensate for any settling of the beds.
- B. The activated carbon shall be pelletized catalytic activated carbon, derived from bituminous coal. The activated carbon shall be suitable for the vapor phase adsorption of sewage treatment odors. No chemical impregnation of the carbon is permitted.
- C. Activated carbon shall be Sulfadsorb – HC as provided by ECS Environmental Solutions, Midas OCM as manufactured by Evoqua Water Technologies, Minotaur OC by Calgon Carbon, or approved equal, and shall have the following Specifications:
 - 1. Minimum Butane Activity (weight %) 26
 - 2. Minimum Iodine Number, mgI₂/g 1,050

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3.	Maximum Moisture (weight % as packed)	5
4.	Minimum Hardness Number	95
5.	Minimum Apparent Density (g/cc)	0.45
6.	Maximum Mean Particle Diameter (mm)	4.0
7.	Minimum H ₂ S Breakthrough Capacity (g H ₂ S removed/cc carbon) ¹	0.3

¹The determination of H₂S breakthrough capacity will be made by passing a moist (85% R.H.) air stream containing 1% H₂S at a rate of 1,450 cc/min through a 1-inch diameter by 9 inch deep bed of uniformly packed activated carbon and monitored to 50 ppm breakthrough.

2.7 TIE DOWN SYSTEMS

- A. Scrubber and duct shall withstand horizontal loadings of 40 pounds per square foot or the maximum wind load at the location in accordance with the latest edition of the Building Code in the jurisdiction where the system will be installed, for the area under the worst condition, whichever is greater. Type 316L stainless steel clips, anchor bolts, and accessories shall be provided to securely anchor the scrubber and duct to the concrete pad.

2.8 GREASE FILTER/MIST ELIMINATOR

- A. The OC Supplier shall provide two (2) grease filter/mist eliminators (GFMEs) for the inlet duct to each odor control train, as shown.
- B. At the design gas flow rate of 8,000 cfm, each GFME shall remove a minimum of 99.9% of droplets 10 microns and larger and a minimum of 90% of droplets between 5 microns and 10 microns.
- C. Pressure drop through the GFME shall not exceed 1.0 inches W.C. at the design airflow rate.
- D. Construction
 - 1. The grease filter/mist eliminator shall be enclosed in an FRP housing. The housing shall be of hand lay-up construction with the same resins and reinforcements as specified for the odor control vessel. Minimum thickness of the housing shall be 0.5 inches.
 - 2. The grease filter pad shall be 2 inches thick and constructed of woven 316L stainless steel. The mist eliminator pad shall be 4 inches thick and constructed of woven polypropylene. The pad shall be provided in four (4) equally-sized square modules to facilitate removal and replacement.
 - 3. Provide two hinged, side-mounted access covers, one on each side of each GFME enclosure, with quick-release toggle clamps or screws for easy access to the pad segments for maintenance. Hinges and toggle clamps to be constructed of Type 316 stainless steel.
 - 4. Gas inlet and outlet connections shall be circular, flanged connections the same size as the connecting ductwork. Flanges shall be of hand lay-up construction with minimum thickness of ASTM 39882, matching the duct thickness, and in accordance with NBS PS 15-69.
 - 5. Provide a 150# gusseted flanged, 2- inch diameter drain connection with air gap at the bottom of the FRP housing.

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6. At the bottom of the FRP housing, provide an integrally-molded support to adequately support the operating weight of the grease filter/mist eliminator with an additional safety factor.

2.9 FRP FANS

- A. Provide fire-retardant fans composed of FRP with an epoxy or UV gel coating to protect against ultraviolet degradation. Fans shall be installed complete with motors, drives, guards, and coatings of sufficient capacity for the duty required. Fans shall operate to draw odorous air from the various process areas and shall exhaust the foul air through the Systems.
 1. The fans shall use a V-belt drive arrangement as shown, equipped with a slip inlet, drilled outlet flange, Teflon shaft seal, 316 SST shaft, fan guard, and motor enclosure.
 2. Fans shall be factory-fabricated and assembled, factory-tested, and factory-finished with indicated capacities and characteristics.
 3. Basis of fan performance shall be at standard conditions (air density of 0.075 lb/ft³).
 4. Selected fans shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
 5. Fans shall be equipped with lifting lugs.
 6. Nameplate: Each fan shall be furnished with a permanently-affixed 316 stainless steel nameplate with manufacturer's name, model number, serial number, and electrical data.
 7. Mounting: The entire fan and motor assembly shall be mounted on vibration isolators.
 8. Rotating Assembly: Rotating assembly shall be statically and dynamically balanced to balance grade G6.3 per ANSI S2.19 and designed for continuous operation at the maximum rated fan speed and motor horsepower.
- B. Fan shall be constructed such that all surfaces in contact with the corrosive foul air stream are made of solid, corrosion-resistant FRP, model FE as manufactured by The New York Blower Company, Series 41 as manufactured by Hartzell or Model CLUB by Ceilcote/Verantis. All nuts, bolts, and fasteners in contact with the gas stream shall be Type 316 stainless steel and encapsulated in FRP.
- C. Performance: Fan ratings shall be based on tests made in accordance with AMCA Standard 210. Fans shall be licensed to bear the AMCA Certified Ratings Seal for Air Performance. Fans not licensed to bear the AMCA Seal for performance shall be tested, at supplier's expense, in an AMCA Registered Laboratory. Fans shall have a sharply rising pressure characteristic extending throughout the operating range to assure quiet and stable operation. Fan speed and motor size shall be selected by the OC Supplier to meet the required conditions of air flowrate and pressure drop across the biological odor control system and ducting, including the pressure drop in the ducting upstream of the biological odor control system inlet. Fan speed shall not exceed 85% of the maximum allowable driven speed of the fan.
- D. Motor: Motor and drive shall be mounted on vibration isolators. Provide motor with an adjustable base for varying belt tension and belt alignment. Motor shall meet the requirements specified in the table below.

Exhaust Fans – Odor Control 4	
Rating	460V, 3 ph, 60 Hz
Horsepower (max)	See table above

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Speed, max rpm	1800
Enclosure	TEFC, Suitable for Class I, Div 2 Environment
Insulation	Class H
Inverter Duty	Yes
Service Factor	1.0
Space Heater	Yes
Motor Winding Temperature Switches	No

- E. Variable Frequency Drives: Each fan shall be controlled by a VFD mounted in an air-conditioned Fan Control Panel as shown and meeting the requirements of Section 16483, Variable Frequency Controllers.
- F. Sound: Fan manufacturer shall provide sound power level ratings for fans tested and rated in accordance with AMCA Standards 300 and 301. Sound power ratings shall be in decibels (reference IOE-12 watts) in eight (8)-octave bands.
- G. Bearings: Bearings shall be grease-lubricated, precision anti-friction ball, self-aligning, pillow block design. Bearings shall be designed for a minimum L10 life of 30,000 hours (150,000 hours L50 life) when rated at the fan's maximum cataloged operating speed. Fan bearings shall be visible and accessible for inspection and maintenance. Bearings enclosed within the fan housing where they can be exposed to the corrosive gas stream are not acceptable.
- H. Construction: Fan shall be constructed in accordance with the ASTM D-4167 standard specification for FRP fans and blowers to ensure structural integrity. All surfaces exposed to the atmosphere shall be rich in paraffinated resin, shall be stabilized against ultraviolet degradation, and shall include a reinforcement not to exceed 20% "C" grade fiberglass. All parts exposed to the foul air stream shall be constructed of, or encapsulated in, an FRP laminate capable of resisting continuous airstream temperatures of 250 degrees Fahrenheit. All resins shall be clear to allow detection of subsurface imperfections. Use of pigments, gel coats, inhibitors, and additives which may disguise flaws in the laminate is prohibited.
 1. Housing: Fan housing shall be constructed of a fire-retardant polyester resin or Type II PVC with an ASTM E84 Class I rating. Housing laminate construction shall conform to ASTM Standard C-582. Airstream surfaces shall be smooth to minimize resistance and prevent buildup of airborne contaminants. Shaft hole openings shall be fitted with a Teflon closure having a maximum clearance of 1/32-inch to minimize leakage. A flanged inlet and flanged outlet composed of FRP construction shall be furnished on the fan. Inlet assembly shall be bolted to permit wheel removal. Fan shall be furnished with an access door, positioned to avoid collection of condensation, and a 1 inch minimum flanged-type drain connection, positioned at the lowest portion of the fan scroll.
 2. Wheel: Wheel shall be backwardly inclined, single thickness type. Wheel blades shall be airfoil-type blades, which limit load horsepower characteristics, so the motor provided with each fan does not exceed the maximum design motor horsepower. Non-overloading design for increased efficiency. Wheel shall be fabricated of a fire-retardant vinyl ester resin with an A8TME84 Class II rating no greater than 30. Wheel hub shall be permanently bonded to the shaft and completely encapsulated in FRP to ensure corrosion resistant integrity. Steel wheels coated with FRP or wheels with taper-lock hubs are not acceptable.

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3. Shaft: Shaft shall be 316 stainless steel, with an FRP sleeve fixed securely and bonded to the wheel backplate. The sleeve shall extend out through the housing shaft hole for corrosion protection. The shaft first critical speed shall be at least 125% of the fan's maximum operating speed. Shaft shall be counter-sunk for tachometer readings.

I. Belt Drives:

1. Belt drive components shall be sized based on a service factor of 1.4.
2. Pulleys shall be of the fully-machined cast iron-type and shall be keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final balancing.
3. Belts: Oil-resistant, non-sparking, and non-static.
4. Belt drives shall be factory-mounted with final alignment and belt adjustment made after installation.
5. Belt Guard: Provide an OSHA-compliant belt guard composed of FRP on the outside of the fan cabinet. Belt guard or motor cover shall completely cover the motor pulley and belt(s).

- J. Balance and Run Test: The wheel and shaft shall be dynamically balanced on precision balancers. Prior to shipment, completed fans shall receive a final test balance at the specified operating speed.

- K. Final Inspection: All fans shall receive a final inspection by a qualified inspector prior to shipment. Inspection shall include fan description and accessories, balance, welding, dimensions, bearings, duct and base connection points, paint finish, and overall workmanship.

- L. The fan and motors shall be factory-mounted on a structural channel subbase with integral motor slide base.

- M. Expansion joints shall be provided on the inlet and exhaust connections that are suitable for the service (hydrogen sulfide) with multiple layers of nylon fabric impregnated with synthetic compounds and laminated into a strong body by vulcanizing. 316 Stainless steel reinforcing rings or split rings shall be provided for bolting to equipment flanges. Connectors shall be designed to withstand at least two (2) times the operating pressure.

2.10 DUCTWORK

- A. All ductwork from the mist eliminator outlet to the odor control system exhaust shall be supplied by the OC Supplier and shall be sloped to prevent the accumulation of condensate. Materials of construction shall be FRP as specified in Section 15596 – FRP Ductwork.
- B. Ducts shall be of sufficient diameter and design to move the air without undue pressure loss or as shown on the Drawings. The pressure loss of the combined activated carbon adsorption system and the ductwork shall not exceed the maximum pressure available from the exhaust fan at the specified air flowrate operating at non-overloaded conditions.
- C. Provide the required transition pieces to connect the ducts as shown on the Drawings to the exhaust fan outlet and the carbon odor control system inlet. Provide butterfly dampers and expansion joints as specified in Section 15600 – Ductwork Accessories.

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2.11 CONTROLS

A. Field Control Equipment:

1. OC Supplier shall review the electrical drawings to determine the hazardous area ratings of the area and shall provide appropriately rated instruments or intrinsically-safe barriers as appropriate for the devices located in hazardous areas and in accordance with this specification.
2. Pressure gauges shall be provided for the suction and discharge of each fan, mounted at eye level. Pressure gauges shall be in accordance with 17650, Pressure Gauges.
3. Pressure switches shall be provided for the suction and discharge at each fan. Pressure switches shall be in accordance with 17675, Pressure Switches. Field set and verify operation.
 - a. Suction pressure switch setpoint shall be set to trip indicate that the fan is pulling against a closed suction damper.
 - b. Discharge pressure switch setpoint shall be set to indicate that the fan is blowing against a closed discharge damper.
4. Differential pressure transmitters shall be provided for each System's grease filter/mist eliminators and each vessel's media bed.
 - a. Differential Pressure Indicating Transmitters shall be in accordance with 17698 Instrumentation and Control Accessories.
 - b. Initial alarm setpoints shall be per OC Supplier's recommendation. Setpoints shall be adjustable.
5. Process Tubing for Pressure Instruments: Process tubing shall be 1/4 x 0.065-inch seamless, annealed, ASTM A-269 Type 316L stainless steel with Type 316 - 37 degrees stainless steel flared fittings or Swagelock, Parker-CPI, or engineers approved equal flareless fittings.
6. Valves for Differential Pressure Instruments shall be stainless steel ball valves.
7. Provide stainless adaptors as necessary to accommodate process connections to transmitters. Refer to the installation detail on the Contract Drawings for valving and installation requirements for the differential pressure instruments.

B. Control Panels:

1. Provide one (1) independent control panel for each fan (Fan Control Panels), located as shown, and complete with main circuit breaker sized to meet the full-load demand of the system. The panel shall operate from a single 480V, 3-phase, 60 Hz power source. The control panel shall include all required components for proper system control and operation, including, but not limited to a 480/120V AC control power transformer, pilot devices, control relays, and other components as specified herein. Each Fan Control Panel shall also include a local disconnect, a VFD, an outdoor GFCI electrical outlet with weatherproof protective cover, and a sufficiently-sized, separately powered side-mounted air conditioning unit. A clear plastic protective cover shall be provided for each fan control panel to protect the VFD HMI from the elements.
2. Provide one (1) independent control panel for each System for mist eliminator and media bed differential pressure indicator lights (Differential Pressure Panels), located as shown, and complete with main circuit breaker sized to meet the full-load demand required. The panel shall operate from a single 120V, 1-phase, 60 Hz power source, supplied to the main circuit breaker. The control panel shall include all required components for proper system control and operation, such as but not limited to pilot devices, control relays, and other components as specified herein.

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3. The panels shall be assembled using NEMA-rated components. Components designed and built to International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured and labeled in compliance with IEC standards is not acceptable.
 4. Control panel construction, wiring, and components shall meet the requirements of Section 17520, Field Panels.
- C. System Controls:
1. Each odor control System shall be controlled by the interior hard-wired control logic provided in the Fan Control Panels and the Differential Pressure Panel. The control panels shall control all components of the System through hardwired connections to field devices. The odor control System shall generally operate as follows, however the OC Supplier shall provide their proposed operating and control logic for the Engineer's review:
 - a. The controls shall enable on/off fan operation through the control devices installed on the dead front panel.
 - b. Controls shall be tested prior to shipment to the site. The OC Supplier shall verify all overload settings to ensure proper overload settings required for the application are properly set.
 - c. A Run Status indicator light shall be installed on the dead front panel and the signal shall be sent to the plant SCADA system.
 - d. Reset Pushbutton: When any alarm condition occurs, the alarm indication shall remain energized and the associated alarm contacts shall remain in the alarm state until the reset pushbutton is pressed.
 - e. Fans: The fans shall run continuously when in the ON position. Fan speed shall be controlled manually from the VFD potentiometer. Provide a red with white letters laminated nametag below the controls for the fans with the following wording: FANS WILL BE DAMAGED IF RUN AGAINST CLOSED DAMPERS. VERIFY THAT SUCTION AND DISCHARGE DAMPERS FOR THE DUTY FAN ARE OPEN AND THE DAMPERS FOR THE STANDBY FAN ARE CLOSED.
 - f. Motor Fault: A motor fault shall register if any starter overload is tripped, a load monitor detects a high current load (from panel mounted current transducers), or the motor's thermal switch detects a high temperature. For any of these conditions, the fault shall latch until manually reset, an alarm shall be sent to alert operators, and the associated equipment shall stop. Upon reset, all settings shall be re-initiated so that the equipment can resume normal operation. The alarm shall be identified through a local indicator light. Motor Fault Alarm shall also be indicated when a fan has been turned on but the current indicated for the fan is less than a field-determined amperage indicating that the fan has been disconnected from the motor. Motor Fault signal shall be sent to the plant SCADA system.
 - g. VFD Fault: A VFD fault shall register if the VFD overload is tripped, a load monitor detects a high current load (from panel mounted current transducers), or the VFD's thermal switch detects a high temperature. For any of these conditions, the fault shall latch until manually reset, an alarm shall be sent to alert operators, and the associated equipment shall stop. Upon reset, all settings shall be re-initiated so that the equipment can resume normal operation. The alarm shall be identified through a local indicator light. VFD Fault signal shall be sent to the plant SCADA system.

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- h. The fan shall be shut down when the overload alarm condition occurs.
- i. The fan shall be shut down after a time delay (initially set at 25 seconds; adjustable 0-60 seconds) when either a low suction pressure or high discharge pressure alarm conditions occurs. Pilot lights shall be provided on the panel to indicate each of these conditions.
- j. Fan motor space heater shall be energized by the control panel when the motor is off.
- k. Motor Heaters: Provide circuits to run the motor space heater when a motor is not running.
- l. Provide a temperature switch to indicate an alarm condition when the temperature in the panel rises to 3 degrees below the maximum operating temperature of the lowest-rated component in the panel.
- m. Alarms shall be latched such that the alarm indicator light shall remain energized and alarm contacts shall remain in the alarm state until the Alarm Reset pushbutton has been pressed.
- n. Provide elapsed run time meters (ETM) for each fan motor. ETM ratings shall meet or exceed the NEMA rating of the control panel enclosure. ETM shall be six digit, non-reset type.

D. Control Interface – Fan Control Panels:

- 1. Hand Controls: Provide the following dead front mounted hand controls for each Fan Control Panel. Switches shall be in accordance with Section 17550, Panel Instruments and Accessories:
 - a. On/Off selector switch for fan.
 - b. E-stop pushbutton for fan.
 - c. Fan switches and pushbuttons shall interface directly with the fan's motor controller (VFD).
 - d. Provide a black reset pushbutton on the panel dead front door for resetting all alarms.
 - e. Provide a local disconnect for fan.
- 2. Indicator Lights: Provide the following dead front mounted devices for each Fan Control Panel. Devices shall be in accordance with Section 17550, Panel Instruments and Accessories:
 - a. Run Status indicator light for fan.
 - b. Motor Fault indicator light for fan.
 - c. VFD Fault indicator light for variable frequency drive.
 - d. High Discharge Pressure indicator light for fan.
 - e. Low Suction Pressure indicator light for fan.
 - f. Low Differential Pressure indicator light for fan.
 - g. Red alarm beacon mounted on top of each fan control panel to visually indicate an alarm condition.
- 3. Provide the following hardwired input/output signals for communication to the existing Plant Control System. DI = Discrete Input. AI = Analog Input. Where indicated, provide loop power for analog instruments.
 - a. Typical for each fan:
 - 1) Run status – DI
 - 2) Run time – AI
 - 3) Motor fault alarm – DI
 - 4) VFD fault alarm – DI
 - 5) E-Stop activated alarm – DI

- 6) Low suction pressure alarm – DI
 - 7) High discharge pressure alarm – DI
 - 8) Speed feedback – AI
- E. Control Interface – Differential Pressure Panels:
1. Indicator Lights: Provide the following dead front mounted devices for each Differential Pressure Panel. Devices shall be in accordance with Section 17550, Panel Instruments and Accessories:
 - a. High Differential Pressure indicator light for each mist eliminator.
 - b. High Differential Pressure indicator light for each vessel media bed.
 - c. Red alarm beacon mounted on top of each fan control panel to visually indicate an alarm condition.
 2. Provide the following hardwired input/output signals for communication to the existing Plant Control System. DI = Discrete Input. AI = Analog Input. Where indicated, provide loop power for analog instruments.

Run status – DI

 - a. Mist eliminator differential pressure – AI
 - b. Mist eliminator differential pressure high alarm – DI
 - c. Carbon vessel bottom media differential pressure – AI
 - d. Carbon vessel bottom media differential pressure high alarm – DI
 - e. Carbon vessel top media differential pressure – AI
 - f. Carbon vessel top media differential pressure high alarm – DI

PART 3 -- INSTALLATION

3.1 INSTALLATION

- A. All equipment shall be pre-assembled and shipped so that installation can be completed with minimal field fabrication.
- B. The odor control system shall be installed by the CONTRACTOR in accordance with the Contract Documents, the instructions OC Supplier, and Section 15000, Equipment ,General.
- C. OC Supplier shall provide the CONTRACTOR with space and structural requirements, clearances, utility connections, signals, outputs and features required by the manufacturer for the equipment installation.
- D. All electrical and ancillary equipment shall be stored in a climate-controlled building greater than 50 degrees F.
- E. All parts shall be properly protected so that no damage or deterioration will occur in transit or during prolonged storage at the site. All openings in equipment shall be protected against entry of foreign objects.
- F. Each box, crate, and package shall be properly marked to show its contents and net weight.
- G. Media shall be delivered in bags for ease of installation. Long-term media storage is not acceptable.

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- H. All cut edges of fiberglass shall be coated with the specified resins prior to installation.

3.2 SHOP TESTING

A. Carbon Vessel Shop Tests:

1. Provide the services of an independent Testing Inspector to be present at the point of manufacture, upon completion of fabrication and prior to shipment, to perform or witness the following:
 - a. Visual inspection to the requirements of ASTM D2563 Level II.
 - b. Barcol Hardness measurements per ASTM D2583-87.
 - c. Acetone sensitivity test for all internal secondary bonds.
 - d. Glass content by ignition loss on three cutouts per ASTM D2584.
 - e. A one-inch diameter FRP sample shall be taken at a point on the vessel wall. The vessel sample boring shall be patched to original condition with FRP. The analysis shall be performed by Ashland Chemical Co. Analytical Services & Technology Group, Dublin, OH, or equal. The analysis shall use FT-IR spectra and a micro-ATR sampling accessory on a Varian UMA600 IR microscope. The cost of analysis and shipping shall be by the Contractor.
 - f. Hydrostatic Leak Test:
 - 1) Perform on each vessel.
 - 2) Fill to two (2) feet above vessel sump; allow to stand for 2 hours with no visible leakage.

3.3 SYSTEM START-UP AND TESTING

- A. Start-up and testing of the odor control system shall be performed in accordance with the requirements of Section 01650, Equipment Start-up, Demonstration, and Facility Commissioning, and Section 17072, Field Testing, and the requirements herein.
- B. System start-up and testing shall be performed by a direct employee of the OC Supplier and shall commence only after a visual inspection confirming proper installation by the OC Supplier's employee. Local representatives not directly employed by the OC Supplier shall not perform system start-up and testing. OC Supplier shall provide any specialized materials required during start-up.
- C. All testing shall be done in the presence of the Engineer and the OC Supplier.
- D. The OC Supplier shall provide services as follows:
 1. Field test and calibrate equipment and demonstrate to the Engineer that all equipment performs satisfactorily as specified.
 2. Submit field testing reports and certification of proper installation to Engineer and Owner.
 3. Submit start-up data report to Engineer and Owner.
 4. Contractor shall perform the field tests under the supervision of the OC Supplier. The Contractor shall provide all test apparatus required.
 5. List and recommend corrective action for any deficiencies found.
 6. Record inlet air temperature, inlet air relative humidity, inlet airflow rate, media differential pressure, inlet mist eliminator differential pressure, inlet and outlet concentrations of hydrogen sulfide, and other data as may be appropriate.

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7. All data shall be submitted to the Engineer and Owner in written report form. Field testing report shall include, at a minimum, description of testing procedure, summary of all data collected in tabular form, operational comments, confirmation of compliance with performance requirements, and recommendations/corrective actions (if necessary).
8. Upon installation, odor control system supplier shall send sample of installed carbon media to an independent laboratory to confirm carbon H₂S capacity meets specified value. Carbon shall be tested by an Independent Testing Laboratory per ASTM D6646, latest Edition. If the carbon tested does not meet the specified H₂S capacity, the carbon shall be retested at the expense of the OC Supplier. In the event that the tested sample fails on two occasions, the entirety of the carbon shall be replaced at no additional cost to the Owner.

3.4 FIELD ACCEPTANCE TESTS

- A. Field acceptance tests shall be required for all odor control equipment specified herein within four (4) months of installation of the equipment, and then again after six (6) months of initial start-up and testing. All equipment shall be field tested in accordance with the applicable requirements, Section 17072 Field Testing, and Section 15000 – Equipment, General.
- B. No performance or field test shall begin until all air flowrates have been adjusted and balanced in accordance with Section 15590, HVAC Testing, Adjusting and Balancing. Field testing shall include mechanical tests and performance tests as specified below. The OC Supplier shall submit information which fully describes the testing procedure to the Engineer for approval. The OC Supplier shall provide at least ten (10) days notice, after receiving approval of the testing procedure from the Engineer, of such tests to the Engineer and the Owner prior to performing the test. The Owner and the Engineer reserve the right to witness the field acceptance tests. In case of failure of any system component to meet the test requirements, the OC Supplier shall make such alterations as are necessary, and the tests shall be repeated without additional cost to the Owner until the equipment is satisfactory. Certified reports shall be submitted to the Engineer for approval.
- C. Mechanical Test: The entire odor control system with other associated equipment such as fans, instrumentation and controls shall be mechanically tested for at least four (4) hours after initial installation. The test shall be made with airflow being introduced at the design rate. All equipment shall show evidence of mechanical soundness, no evidence of liquid or gas leaks, no undue vibration or heat, and generally be structurally rigid when being tested.
- D. Performance Test: The OC Supplier shall test the system to meet the design conditions of service. Performance testing shall take place between the months of May and September during warmer weather with higher odor load conditions. The ability of the equipment to meet the performance requirement shall be determined by the capability of reducing H₂S as specified above.
 1. The OC Supplier will be furnished the following items by the Contactor for testing:
 - a. Portable manometer: 0 to 10 inches W.C., for differential pressure loss measurement across each media bed.
 - b. Air velocity meter for airflow measurement into the odor control vessel.
 - c. Portable H₂S analyzers for inlet and outlet gas concentrations – Acrulog/Odalog Low Range (0.05 – 2 ppm), or equal, for outlet and Acrulog/Odalog 0-50 ppm, or equal, for inlet.

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- d. All labor and equipment that the OC Supplier's field engineer requires for conducting the tests.
2. H₂S Test Procedures: The test shall be conducted for a thirty-two (32) hour period at design airflows. Inlet and exhaust samples shall be taken at 10-minute intervals and shall be logged for the entire period. H₂S sampling methods shall conform to the following standards:
 - a. Inlet and exhaust H₂S concentrations shall be measured and continuously logged using the portable H₂S gas analyzers specified herein.
 - b. H₂S analyzer shall be factory-calibrated prior to the test to ensure reliable test results. Calibration shall be performed both prior to and after the test period and calibration certificates shall be submitted to the Engineer.
 - c. Inlet concentration data shall be collected from the inlet ductwork to the odor control system. Exhaust samples shall be taken from each odor control system exhaust stack.
 - d. Record airflow at each exhaust stack and differential pressure for each bed twice daily for each week-long testing period.
 - e. Should the system performance not meet the above requirements, the system shall have failed the performance test. The OC Supplier shall make any additions or modifications to the system as may be necessary, at no additional cost to the Owner, and the performance tests for that system shall be repeated in its entirety.
 - f. In the event of three (3) failed performance tests, the system will be rejected and the Contractor shall remove equipment within 30-days and refund the Owner the entire bid price.
 - g. The OC Supplier shall submit a written report to the Engineer summarizing the data collected during the field acceptance tests demonstrating compliance with the system requirements.
 - h. The OC Supplier's representative witnessing the field tests shall submit a written report to the Engineer certifying that the odor control system:
 3. Has been properly installed and accurately aligned.
 4. Is free from any undue stress imposed by connecting piping and/or anchor bolts.
 5. Has been operating within an acceptable range of the specified design criteria and that the odor control system unit operates satisfactorily.
 6. The data obtained during the field testing has been accurately recorded.

3.5 PAINTING

- A. All paint and coatings shall be shop applied in accordance with Section 09900 – Painting.

3.6 TOOLS, SUPPLIES AND SPARE PARTS

- A. The OC Supplier shall furnish all recommended spare parts. At a minimum, the odor control system shall include the following spare parts:
 1. One (1) set of gaskets for all gasketed covers and connections.
 2. One (1) set of bearings for each fan.
 3. Two (2) sets of fan belts for each fan.
 4. Two (2) spare set of pads/filters - one for each grease filter/mist eliminator.
 5. Six (6) carbon saturation indicators.

3.7 EQUIPMENT IDENTIFICATION

- A. Each piece of equipment shall be provided with an equipment nameplate in accordance with Section 15000, Equipment, General, which will be securely fastened in a conspicuous place and clearly inscribed with the OC Supplier's name, year of manufacture, serial number, and principal design criteria.

END OF SECTION

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SECTION 14600

CRANES AND HOISTS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, install, and make fully operational the crane and hoist systems in the locations and conditions of service, as shown on the Drawings and as specified in the Crane and Hoist Schedule.
- B. These Specifications shall be considered as minimum requirements. The Contractor shall add such additional features as are necessary for satisfactory operation.
- C. Equipment shall be provided in accordance with the requirements of Section 11000 – Equipment General Provisions.
- D. All equipment supplied under this Specification shall comply in all respects with the provisions of the Occupational Safety and Health Act of 1970, including all standards promulgated under the authority of such Act, and shall also meet all applicable industrial codes in the State in which the project is located.
- E. The manufacturer and ultimately the Contractor shall be totally responsible for structural design of the crane and hoist systems, for the compatibility of all equipment, and for verification of required operating clearances.
- F. All parts of the mechanism furnished shall be amply designed and constructed for the maximum stresses occurring during fabrication, erection and continuous operation. All equipment specified herein shall be designed for the Crane Manufacturer's Association of America Duty Classification as specified herein.
- G. If the Contractor elects to utilize the crane and hoist equipment in any way during the erection of piping and installation of equipment, he shall notify the Owner in writing and shall provide for an inspection by the equipment manufacturer and take any steps necessary to return the equipment to "as new" condition. He shall also obtain recertification by the manufacturer and reinstate all warranties and guarantees.

1.2 CAPACITY AND DESIGN LOADS

- A. The crane shall be designed to withstand the dead load (caused by the weight of the crane and components themselves), the live load and hoist load, and the inertia forces caused by movement of the crane, components, and loads during standard operation.
- B. Standard capacity ratings shall represent the net rated load at the hook of any type of trolley hoist with the same load rating installed on the crane having a trolley hoist weight within the established limits.

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- C. All design loads shall meet CMAA requirements. The design load for stress calculations shall be based upon the capacity plus 15% for the weight of the hoist and trolley and an additional 25% for impact (capacity x 1.4). Design load for deflection calculations shall be based upon the capacity plus 15% for the weight of the trolley hoist (capacity x 1.15).
- D. The rated load capacity of each crane shall be clearly labeled on each crane using a label size easily read from the floor level and/or loading position.

1.3 CRANE AND HOIST SCHEDULE

Location	North Grit Chamber	South Grit Chamber	North Grit Auger Drywell	South Grit Pump Room	Odor Control Room
General					
Indoor / Outdoor	Outdoor	Outdoor	Indoor	Indoor	Indoor
Capacity, tons	1	1	0.5	1	0.5
Operating Floor Elevation	748.5	748.5	731.5	731.5	741.0
Crane					
Crane Type	Monorail	Monorail	Jib Crane, Wall Mounted	Monorail	Monorail
Trolley Hoist					
Trolley Type	Electric	Electric	Manual	Manual	Manual
Hoist Type	Electric	Electric	Manual	Manual	Manual
ASME Duty Classification	Class H3	Class H3	Class H1	Class H1	Class H1
Hook Elevation					
High Point	758.5	758.0	739.0	753.52	753.42
Low Point	728.5	731.5	731.5	731.5	741.42
Operating Speeds					
Trolley Speed, fpm	65 (Max.) - VFD	65 (Max.)-VFD	Manual	Manual	Manual
Hoist Speed(s), fpm	20 (Max.) / 3 (Min)	20 (Max.) / 3 (Min)	Manual	Manual	Manual

All elevations and spans are approximate. All equipment shall be installed as shown on the Drawings.

1.4 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced Specifications, codes and standards refer to the most current issue available at the time of the Bid.
 1. CMAA Crane Manufacturers Association of America

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| 2. | AISC | “Manual of Steel Construction” |
| 3. | ASTM A48 | Standard Specifications for Gray Iron Castings |
| 4. | ANSI B30.11 | Safety Code for Underhung Cranes and Monorail |
| | Systems | |
| 5. | ANSI B30.16 | Safety Code for Overhead Hoists |
| 6. | MMA MH27.1 | Monorail Manufacturers Association |
| 7. | OSHA 1910-179 | Occupation Safety and Health Administration |

1.5 SUBMITTALS

- A. Certification that the equipment has been field tested and passed.

1.6 WARRANTY AND GUARANTEE

- A. The manufacturer will warrant against any defects in material or workmanship to the crane and hoist equipment. This warranty will commence upon delivery of the products and will expire on the earlier to occur of one (1) year from initial operation of the product or 18 months from delivery thereof (the “Warranty Period”).

PART 2 -- PRODUCTS

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a. TROLLEY HOISTS

- A. Trolley hoists shall be as manufactured by ACCO Industries, Electrolift, or Yale.
- B. All load carrying parts shall be of steel. The wheels shall have hardened treads. Wheels and axles shall be equipped with antifriction bearings which are permanently sealed and lubricated. The gear head of the motor shall have an alloy steel, heat-treated gear train operating in a fully enclosed oil bath. The gear shaft shall have precision, oil lubricated ball bearings. Where monorail track as specified or shown on the Drawings is curved, trolleys shall be the swivel-type to negotiate curved sections.
1. Electrically operated trolleys shall include variable frequency control with 2-step in, a gearmotor with solid-state soft start with adjustable time and torque, and electric brake.
 2. Manual trolleys shall be of hand-driven geared type.
 - a. Chains shall be constructed of forged stainless-steel material.
- C. The hoist drive shall be of the close headroom-, double reeved, cross mounted- type and shall include a geared train with inherent or mechanical load brake, hook, wire rope, and drum. Rated capacity shall be stamped on the hoist frame. The frame shall be oil-tight, of cast steel construction, with no part of the load carried by assembly bolts. Gearing shall be machine cut and -heat-treated and shall operate in an oil bath. Except for the drum pinion, no gears shall be cantilever mounted. Shafting shall be ground and polished and all bearings shall be of the antifriction type. Grease fittings and oil reservoir shall be readily accessible. The drum shall be of the large diameter, guarded, flanged type with machine cut grooves to accommodate the hoist cable without overwrapping. Right- and left-hand drum grooving shall be utilized in close-headroom, double-reeved, cross-mounted hoist applications to provide a true vertical lift. The wire ropes shall be of the preformed extra flexible type, have a safety factor of at least five, and be anchored to the hoist drum. The load block shall be of the safety type with guarded sheaves and forged swiveled hooks. Hooks shall open slowly when subjected to heavy overloads.
1. Electrically driven hoists shall include a two (2) speed, direct coupled motor, electrical controls, and solenoid brake. The solenoid brake shall be spring set with magnetic release operated by and interlocked with the electrical control equipment. Either a worm gear drive with an inherent load brake or a mechanical load brake designed in accordance with the Hoist Manufacturer's Institute standards shall be provided for controlling the speed when lowering, and for holding maximum hook load for any load up to capacity. Stressed parts shall be of cast or forged steel. In the event of a power failure the braking system shall automatically lock the piece of equipment being lifted to prevent further movement. Hoists shall also include either a clutch-type or electric-type overload cut-off device to protect hoist from an overload condition.
 2. Manual hoists shall include a handwheel and chain and a clutch-type overload cut-off device to protect hoist from an overload condition.
 - a. Chain, hooks and safety latches shall be constructed of forged stainless-steel material.
 - b. A chain container shall be provided to store chain.
- D. Rated capacity of trolley hoists shall be painted with stencil on the trolley hoist.

2.2 ELECTRICAL AND CONTROL REQUIREMENTS

- A. Electrical power wiring and connection to the electrical system not integral to the equipment shall be provided under Division 16, Electrical. All other power wiring associated with and integral to the hoist systems shall be furnished and installed under Division 14.
- B. All electrical appurtenances furnished by the equipment manufacturer shall be rated for installation in classified areas where such areas are indicated on the Drawings or specified herein.
- C. All wiring between motor, limit switches and starters shall be short, compact and protected by rigid galvanized steel conduit or flexible steel neoprene jacketed cable. In corrosive areas [i.e. Headworks], rigid galvanized steel conduit shall be PVC coated.
- D. The Electrical System providing power to the bridge crane drives, trolley drives, and hoists shall be the festoon type as specified herein.
 - 1. **Festoon Type:** A track supported festoon system shall be supplied where specified herein and shall include trolleys with tandem wheels of a corrosion resistant material which shall provide suitable service with the track that is used. The trolleys shall have saddles for supporting the cables in equal loops not exceeding 9'-0" of cable per loop. The track shall be stainless steel and supported at spans not exceeding 6'-0". The track shall be adequately supported with horizontal arms spanning to the festoon tow bar. The equipment manufacturer shall be fully responsible for the design and suitability of the festoon system.
- E. Starting equipment shall be integral with the crane drives and/or trolley hoist unit with three overload elements. Equipment shall be housed in an enclosure suitable to the conditions of service and as specified herein.
- F. Hoisting motors shall be a twospeed motors. The trolley motors shall be a single speed squirrel cage induction motors NEMA Design "D". Motors shall be of the totally enclosed type designed for hoist service. The motor rating shall be on a 30minute 55°C, duty cycle basis.
- G. Electrical/Control Requirements

	North Grit Chamber	South Grit Chamber
Area Classification	Class I, Division 1, Group D	Class I, Division 1, Group D
NEMA Rating of Components	NEMA 7	NEMA 7
Electrical System	Festoon	Festoon
Control System	Remote	Remote
Motors		
Rating	460V, 3 ph, 60 Hz	460V, 3 ph, 60 Hz
Trolley Motor HP	1	1

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Hoist Motor HP	5 (Two speed)	5 (Two speed)
Enclosure	TEFC-XP	TEFC-XP
Insulation	Class F	Class F
Inverter Duty	No	No
Service Factor	1.15	1.15
Space Heater	Yes	Yes
Motor Winding Temperature Switches	Yes	Yes

- H. Limit switches shall be approved geared typed, positive in action, compact, oil proof and readily accessible. Solenoid brakes shall be disk type, spring set with magnetic release. Solenoids shall be totally enclosed, protected from oil and moisture, readily accessible for adjustment and maintenance and shall develop the required forces without overheating.
- I. All electrical and control components shall conform to the applicable standards of UL and NEMA, unless specified otherwise. International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.

2.3 CONTROLS

- A. The Control System providing control of the bridge crane drives, trolley drives, and hoists shall be through “belly box” wireless radio controls as specified herein.
 - 1. Radio controls for lift and travel shall be provided complete with transmitter, receiver, and mounting hardware, designed for both indoor and outdoor installations. Transmitter shall be battery powered, consisting of a NEMA 7 gasketed, glass reinforced nylon enclosure with removable power key. Two speed control of the hoist drive shall be affected by a two-step pushbutton. A 110 VAC, 60 Hz receiver shall be panel mounted with NEMA 7 sealing. LED lights shall be furnished with the receiver for visual diagnostic feedback. Radio frequency shall be microprocessor controlled with a range of no less than 300 feet. Radio controls shall be manufactured by Enrange, Telecrane, or equal.
- B. Control power shall be 120 volt, provided by a control power transformer within the starter units. One side of this transformer shall be grounded, the other side shall be connected via a fuse of adequate rating.

PART 3 -- EXECUTION

3.1 MANUFACTURER’S FIELD SERVICES

- A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 11000, Equipment General Provisions and shall include the following site visits for each crane and hoist system:

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Service	Number of Trips	Number of Days/Trip
Installation and Testing	1	1
Startup and Training	1	1

3.2 INSTALLATION

- A. All crane equipment shall be installed in accordance with the applicable sections of Division 5 - Metals, Division 16 – Electrical, and the manufacturer's instructions and recommendations.

3.3 FIELD TESTS

- A. Field tests shall be conducted in accordance with Section 11000 and the manufacturer's instructions and recommendations. Prior to initial use, all cranes shall be proof-tested at 125% of their rated load in accordance with all OSHA requirements.

3.4 PAINTING

- A. The crane shall be painted OSHA safety yellow before shipment.
- B. A wire-brushing and/or solvent wipe shall be performed prior to painting to clean and remove debris, mill scale, dirt, and oils.
- C. At least one spray can of matching color paint shall be shipped with each crane for field touch-ups.
- D. The crane shall be properly banded and skidded prior to shipment. Any paint damage, scratches, blemishes to the finish of the crane, caused by shipping, transportation via common carrier, etc., shall be repaired by the Contractor.
- E. Rated capacity of crane system shall be painted with stencil on all components of crane system as specified herein.

- END OF SECTION -

SECTION 15000

EQUIPMENT, GENERAL

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

- A. This section is comprised of standards of construction and materials for those divisions of these Specifications under which process and service equipment is provided and installed including, but not limited to, piping, valves, pumps, blowers and other equipment. The Contractor shall refer to the Equipment Specifications to ascertain which systems required to provide. Construction methods and materials for special systems, not described in this section are specified under the detailed section to which they apply. Where more stringent construction methods are required than imposed by this section, they are specified in the detailed sections and shall apply.

1.2 WORK INCLUDED

- A. These specifications and the accompanying drawings are intended to comprise the furnishing, layout, coordination and installing of all materials, equipment, ancillary components and supplies as specified herein and required for the satisfactory completion by the Contractor of all work including the installation of any Owner furnished equipment.
- B. The drawings and these specifications are complementary to each other in that all components, materials and equipment shown on the drawings and/or specified herein shall be considered essential to the contract requirements.
- C. The Contractor is responsible for all work shown on the drawings and all the systems described herein, unless otherwise shown on the drawings or specified herein.
- D. All components and equipment furnished and installed by the Contractor must be of such dimensions and design as to be adapted to the arrangement of the installation and to fit within the limits of the space available for them.

1.3 ITEMS SPECIFIED ELSEWHERE

- A. Section 01300 - Submittals
- B. Section 01400 – Quality Control
- C. Section 01600 – Material and Equipment
- D. Section 01650 – Equipment Start-Up, Demonstration, and Facility Commissioning
- E. Section 01730 – Operations and Maintenance Data
- F. Section 01950 – Sequence and Special Conditions

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- G. Section 03300 – Concrete Work
- H. Section 09900 – Painting.
- I. Section 15170 – Motors
- J. Section 16010 – Electrical, Instrumentation & Controls Requirements
- K. Equipment and Valve schedules shown on the drawings

1.4 SUBMITTALS

- A. Shop drawings are required for each item of equipment, apparatus, device and piping furnished, refer to Division 1.
- B. Submit operation and maintenance manuals per Division 1
- C. Submit equipment and valve tag list prior to engraving.
- D. As-Built drawings are required for all equipment.

PART 2 PRODUCTS

2.1 AREA DESIGNATIONS AND MATERIALS

- A. Unless otherwise specified, materials for miscellaneous metals, products such as anchors, hangers and supports, hardware (nuts, bolts washers), and spacers/plates etc. shall be designated in accordance with the atmosphere, location and/or condition of service. The following table shall be used to select materials:

Area Designation	Process/Building Areas	Materials
Chemically Corrosive	Chemical Feed Facilities such as ferric/ferrous chloride, caustic, chlorine, and chlorine compounds	PVC, FRP, HDPE, PVDF, 316 SS and Titanium. Material selection must be compatible with the product. (Note: SS shall not be used directly with chlorine related compounds.)
Heavily Corrosive	Wastewater such as collection, preliminary, and primary treatment processes, tanks, and chambers.	316 (L) SS
Moderately Corrosive	Secondary and tertiary treatment processes, tanks, and chambers CSO facilities. Processes containing chlorinated drinking water with free chlorine greater than 0.5 mg/L.	304 (L) SS

Mildly Corrosive	Below grade facilities such as pipe galleries, dry wells, vaults, etc.	304/316 SS for materials and products attached to floor, galvanized carbon steel for all other areas.
Neutral	Administration Buildings, electrical and control rooms, service buildings, garages, or non-process treatment buildings.	Painted/coated carbon steel

B. STAINLESS STEEL

1. 304L and 316 L – Low Carbon stainless steel – shall be used for all welding applications. 304/316 shall be used for all other applications. 316 (L) shall be used for all applications visible without confined space entry.
2. Stainless steel shall meet ASTM A240, A 312, A403, A774, A778, and must be pickled.

- C. PVC, FRP, HDPE, PVDF plastics and other materials must be appropriate for the chemical/application. Contractor shall submit materials suitable for the process.

2.2 PRESSURE GAUGES

- A. Pressure gauges shall be installed at the following locations:

1. Inlet and outlet of all reciprocating, centrifugal, and positive displacement mechanical and process equipment.
2. As shown on the Drawings and as called for in process equipment specifications.

- B. Each gauge shall be 4 1/2" dia. dial size, liquid filled (glycerin & water), 316 S.S. case, stem mounted, accurate to 2% of scale at mid scale, SS movement, adjustable micrometer pointer, stainless steel bourdon tube and socket, dial range shall be as indicated on the Drawings or as specified in the various process equipment specifications, Model 450LFSS as manufactured by H.O Terrice Co., Ashcroft, or Owner approved.

- C. Each gauge shall be complete with a impulse damper and gauge cock. Pressure gauges on process lines as detailed on the Drawings shall be furnished with diaphragm seals and isolation valve. Diaphragm seals and gauges shall be 1" size, carbon steel body and Buna-N sleeve, Series 742 as manufactured by Red Valve or equal. Diaphragm seals shall be equipped with an isolation valve and flushing valve, both of which shall be ball valves, Jamesbury Style 21-22 with carbon steel body and ball stainless steel stem and TFE seals and seat.

2.3 HAZARDOUS MATERIALS

- A. No Asbestos, Polychlorinated Biphenyl (PCB) or Mercury containing materials shall be allowed on the job site.
- B. No asbestos gaskets, packing insulation, etc. shall be furnished as a part of any item provided under these specifications.

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2.4 OIL AND GREASE FITTINGS

- A. The Contractor shall furnish all oil and grease required to place all of the equipment in initial operation. Oil and grease shall be in accordance with the equipment manufacturer's recommendations.
- B. Oil and grease fittings throughout the entire job shall be of one standard type, as approved by the Owner. Where equipment is furnished by the manufacturer with non-approved fittings, the Contractor, at his own expense, shall provide and install standard fittings.
- C. All fittings shall be installed in a readily accessible location or provided with extension lines for ease in lubrication.
- D. All oil fill and drain parts shall be plumbed to provide ease of access to fill and drain each port. Ball cocks shall be provided to help facilitate oil maintenance regardless of whether or not they are shown on the drawings.
- E. Grease fittings for all non-greaseable motors shall be removed.

2.5 NAMEPLATES

- A. Equipment Nameplates
 - 1. Each major component of equipment, unless otherwise specified, shall have the equipment nameplate securely attached to the item or equipment.
 - 2. Nameplates shall identify the following:
 - a. Equipment Name
 - b. Equipment ID Number
 - c. CMMS or Asset ID Number
 - d. Serial Number
 - e. Model Number
 - f. Capacity or Duty Point
- B. Valve Tags
 - 1. Valve tags shall be provided for all valves greater than 4 inches in diameter and on all actuated valves. The tag shall include the Valve ID number and CMMS or Asset ID Number.
- C. The list of Equipment Nameplates and Valve Tags shall be submitted for approval.
- D. Nameplates and tags shall be stainless steel or white laminated plastic with engraved black letters. The tags shall be 1-1/4" high and 3-1/2" wide (minimum) and shall be securely attached to the equipment by means of stainless steel countersunk head machine screws with Phillips slots. Equipment and valve tags can be secured with zip-ties, if acceptable to Owner. The plates shall be approximately 3/32" thick with beveled edges and shall have letter sizes and legends as approved by the Owner.

2.6 V-BELT DRIVES

- A. Drives selected by the contractor shall be matched combinations rated by the manufacturer at not less than 150% of the motor nameplate horsepower. Sheaves shall be single groove for

fractional horsepower motors and multiple groove for motors one horsepower and over. V-belts shall not be less than size "B" static conducting high capacity belts. Static proof belts shall be Cog-Belt as manufactured by Dayco or equal.

- B. Drives shall be installed complete with matched belts, slide-rail motor base (or its approved equivalent) and belt guard. Belt drives shall be outboard of bearings, to eliminate the necessity for any disassembly when belts are changed. Drive guards conforming to OSHA requirements shall be furnished and installed on all drives.
- C. Provide each V-belt drive with sliding base or other suitable tension adjustment. Adjustment mechanism to be 304 stainless steel.

2.7 GUARDS FOR DRIVES AND ROTATING PARTS

- A. Unless guards are provided integral with the equipment each belt drive shall be enclosed in a galvanized 16 gage sheet steel guard, fastened to an approved structural iron frame. The frame shall be built in sections and bolted together for easy removal. The guards shall be securely fastened to the equipment housing. Convenient access doors shall be provided at shaft centers.
- B. Guards shall be easily removable, of material suitable for the environment, and painted safety yellow. Slotted openings to facilitate removal which are large enough to allow finger penetration shall be blocked by an adjustable cover.
- C. A solid guard of No. 16 gage galvanized steel shall be installed over the coupling of each item of direct driven equipment. Sides are not required on guards installed on horizontal couplings except to provide rigidity.
- D. All guards shall meet the requirements of MIOSHA regulations for Machine and Equipment Guards.

2.8 GEAR REDUCERS AND DRIVE COMPONENTS

- A. Size drive equipment capable of supporting full load including losses in speed reducers and power transmission.
- B. Provide nominal input horsepower rating of each gear or speed reducer at least equal to nameplate horsepower of drive motor.
- C. Design drive units for 24 HR continuous service, constructed so oil leakage around shafts is precluded.
- D. Utilize gears, gear lubrication systems, gear drives, speed reducers, speed increasers and flexible couplings meeting applicable standards of American Gear Manufacturers Association.
- E. Gear reducers:
 - 1. Provide gear reducer totally enclosed and oil lubricated.
 - 2. Utilize anti-friction bearings throughout.
 - 3. Provide worm gear reducers having a service factor of at least 1.20.

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4. Furnish other helical, spiral bevel, and combination bevel-helical gear reducers with a service factor of at least 1.50.

2.9 INSERTS AND ANCHOR BOLTS

- A. All anchors must meet Section 05051
- B. All equipment and supports which must be secured to concrete walls, ceiling slabs, columns and other building masonry (except floors) shall be attached by means of approved inserts embedded in concrete or masonry.
- C. All equipment anchors shall be designed by the equipment manufacturer in accordance with Section 05051. Materials shall comply with the area designation, environment and conditions. Anchors can be provided by the contractor.

2.10 LIFTING LUGS

- A. Provide lifting lugs on all equipment 50 LBS or greater, and a ceiling eye-bolt suitable to lift and support the equipment.
- B. Provide on other equipment or products as specified in the individual specifications.

PART 3 EXECUTION

3.1 DRAWINGS AND MEASUREMENTS

- A. The drawings show the arrangement, general design and extent of the systems. Elevations and dimensions of existing pipes, floors, and walls and other structures or equipment may not be exact. The equipment, main lines and connections are shown more or less in diagram and in their general locations, except where, in certain cases, the drawings may include details giving the exact location and arrangement.
- B. The drawings are not intended to be scaled for roughing-in measurements nor to serve as shop drawings. Shop drawings are required for these purposes made from field measurements and shall be prepared by the Contractor.
- C. The contractor is required to confirm all critical elevations and dimensions prior to preparing shop drawings.
- D. Field measurements necessary for material demolition and fitting for the installation shall be completed by the Contractor.
- E. Shop drawings and/or equivalent information shall be submitted to the contractor by sub-contractors and will be passed upon by the Owner and returned through the Contractor.
- F. Shop drawings and/or equivalent information shall be processed in accordance with Division 1 and any additional requirements of the detailed sections.

3.2 LINES AND GRADES

- A. Work shall be constructed in conformity with lines and grades as indicated on drawings. Bench marks as shown on drawings shall be used from which lines and grades required for installation of mechanical work may be set.
- B. The Contractor shall lay out his work and be responsible for lines, elevations and measurements required for the installation of his work.

3.3 CUTTING AND REPAIRING

- A. All cutting and repairing of existing and completed work, including manholes, which is required for the installation of the Contractor's work shall be done by the respective contractors for the various trades involved, at the Contractor's expense.
- B. The Contractor shall provide openings in the floors, manholes, walls, etc., as required for the installation of the piping and equipment.

3.4 DISPOSAL OF SALVAGED MATERIAL

- A. All existing piping, valves and equipment which are required to be removed as part of this project shall be cleaned by the contractor and stored at a location on the site as designated by the Owner.

3.5 STORAGE AND HANDLING OF MATERIALS AND EQUIPMENT

- A. Materials and equipment may be stored on the site in locations designated by the Owner.

3.6 COORDINATION

- A. Before proceeding with the installation of equipment, piping, ductwork or other system, the Contractor shall inspect the contract documents and determine that the location of the installation does not interfere with other work. In case of interference, the Owner shall be notified immediately in writing. The Owner shall then determine the resolution of the interference and shall so inform the Contractor. The Owner's decision shall be binding.

3.7 EQUIPMENT BASES

- A. All equipment on concrete floors shall be mounted on minimum 6" high concrete pads, unless otherwise specifically noted on the drawings or specifically not required by the equipment manufacturer for proper installation. Equipment shall not operate until concrete and/or grout has cured. Concrete and reinforcing steel shall satisfy all sections of Division 3 of the specifications.
- B. All motor driven equipment installed by suspension from the building structure shall be so designed and so installed as to effectively isolate all vibration of the equipment from the building structure. The Engineer will reject any installations where equipment vibration is not effectively isolated.

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- C. Unless otherwise shown on the drawings, motors and the equipment they drive shall be mounted on common bases set on concrete pads.
- D. All structural steel pump bases shall be curbed or drained as detailed on the drawings to retain seal leakage and enable its collection. Provide 3/4 IN PVC or clear plastic tubing from equipment base to nearest floor or equipment drain. Route clear of major walkway areas and as approved by Engineer.
- E. Provide blocks and shims at each anchor bolt that are square shape with "U" cut out to allow blocks and shims to be centered on anchor bolts. Do not use nuts below the machine base on anchor bolts for base leveling.

3.8 ALIGNMENT

- A. Piping connections to all pumping equipment shall be disconnected after installation and prior to alignment, in the presence of the Engineer, to verify that no strain is being placed on the pump nozzles by the piping. Movement shall not exceed 0.002 inches.
- B. Laser alignment systems shall be utilized unless otherwise approved by the Engineer. A report shall be issued to the owner that documents, as a minimum, the date, time, technician, alignment tolerance (as specified by the Manufacturer), initial and final shaft orientations (gap, angular and offset measurements), and the changes made. The report shall describe the instruments and methods used to measure and calculate the machine moves. It shall describe any other measurements or abnormalities detected including but not limited to:
 - 1. Shaft runouts
 - 2. Uneven bases
 - 3. Soft foot corrections
- C. If equipment is delivered as a mounted unit from factory, verify factory alignment on site after installation and realign, if necessary.
- D. Equipment shall be realigned after running for a sufficient period of time which establishes a consistent temperature rise. Check surfaces for runout before attempting to trim or align units.
- E. Where shims or blocks are required, they shall be stainless steel, commercially die-cut, and not more than three can be used at one location. After all leveling and alignment has been completed and before grouting, tighten anchor bolts to proper torque value.

3.9 GROUTING

- A. After equipment base has been shimmed, leveled, couplings aligned and anchor bolts tightened to correct torque value, a dam or form work shall be placed around base to contain grouting to install the grout as shown on the Contract Drawings. Extend dam or form work at least 1/2 inch above the top of leveling shims and blocks.
- B. Saturate top of roughened concrete subbase with water before grouting. Add non-shrink grout until entire space under machine base is filled to the top of the base underside. Puddle grout by working a stiff wire through the grout and vent holes to work grout in place and release any entrained air in the grout or base cavity.

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- C. When the grout has sufficiently hardened, remove dam or form work and finish the exposed grout surface to fine, smooth surface. Cover exposed grout surfaces with wet burlap and keep covering sufficiently wet to prevent too rapid evaporation of water from the grout. When the grout has fully hardened (after a minimum of 7 days) tighten all anchor bolts and recheck driver-driven unit for proper alignment. Equipment shall not operate until grout has cured.

3.10 CONNECTIONS

- A. Provide unions to all equipment w/ connections less than 3 inches in diameter and Victaulic or Dresser style for equipment 3 inches and above.
- B. Provide dielectric unions on all dissimilar metal connections
- C. Dresser style connections shall be thrust-restrained on all pressurized pipe over 10 psi.

3.11 MAXIMUM PERMISSIBLE NOISE LEVEL

- A. All steady or cyclical noise levels produced by machinery or equipment at the operator's position, and at all other points five feet from the equipment, shall not exceed 85 decibels (unless otherwise specified) when measured by a sound level meter meeting ANSI S1.4-1971, "Specification for General Purpose Sound Level Meters" set to "A" weighting and slow response.

3.12 VIBRATION

- A. Equipment shall be designed and installed so as to preclude excessive vibration. The Engineer will reject any installations where excessive equipment vibration is in evidence.
- B. Vibration test shall be performed by a certified technician acceptable to the Engineer.

3.13 WELDER QUALIFICATIONS AND PROCEDURES

- A. All welding of piping covered by this specification, regardless of conditions of service, shall be performed according to these provisions.
- B. For high pressure systems, 250 psi and above, pipe welding shall comply with the provisions of the latest revision of the following applicable codes, rules or regulations.
 - 1. Rules for construction of power boilers (Sections I, VI, and appendix, ASME Boiler and Pressure Vessel Code).
 - 2. Qualification standard for welding procedures, welders, and welding operators (Section IX ASME Boiler and Pressure Vessel Code).
 - 3. Code for pressure piping ANSI 831.1 with supplement No. 1 ANSI B 31.1A.
 - 4. State or local requirements as may supersede the above codes.
- C. Standard procedure specifications and welders qualified by the national Certified Pipe Welding Bureau shall be considered as conforming to the requirements of these specifications.
- D. Each welder shall provide proof of certification for both the material being welded and the techniques being utilized.

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- E. All pipe welding may be by either oxy-acetylene or arc method and shall be done by approved welders. Welding procedures and joint quality shall strictly conform to above procedures. The Owner reserves the right to require qualifying demonstrations at the Mechanical Contractor's expense, of any welders assigned to the job.
- F. Tee connections in welded piping shall be made with a factory fabricated butt welding tee or with Weld-o-lets. The size of the branch connection shall be one-half the diameter of the main or less. Scarf welding or direct butt welding of side connections shall not be permitted. Tees fabricated from pipe shall not be permitted.
- G. Long radius welding ells shall be used in changing pipe directions of welded pipe lines. Mitered joints shall not be used unless specifically approved by the Owner in writing.
- H. When welding cement mortar lined pipe, the contractor shall ensure that no damage is done to the lining. Inspection and/or verification is required after welding.

3.14 TEMPORARY USE OF INSTALLED EQUIPMENT

- A. If it becomes necessary for temporary use of the systems by the Contractor, before all parts are complete, the Contractor shall adjust all parts as far as possible in order to make said temporary use as effective as possible.
- B. If such temporary use is for the Owner's benefit and cleaning or repairing of damage is necessary due to the Owner's actions, such cleaning and repair cost shall be paid by the Owner based on a prior negotiated price.
- C. After temporary use and before acceptance tests, all systems shall be readjusted to meet permanent operational requirements. All systems shall be cleaned internally and externally before placing in operation, and any damaged surfaces shall be restored to as new condition.

3.15 MAINTENANCE PRIOR TO SUBSTANTIAL COMPLETION

- A. The Contractor shall be responsible for the maintenance of equipment and systems installed or stored until final acceptance by the Owner.

END OF SECTION

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SECTION 15060

EXPOSED PROCESS PIPE AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY OF WORK

- A. Covers all piping, fittings and appurtenances installed in above grade, interior and exposed conditions used for process service.
- B. Furnish all labor, materials, tools, equipment, testing, and supervision required to complete all piping systems, as indicated on the drawings and specified herein, and all other work incidental thereto, except as otherwise noted.
- C. The requirements of Section 15000, "Equipment, General" form a part of this Section and govern work covered in this Section.
- D. In the event that provisions of this specification conflict with information on a pipe schedule provided in the contract drawings, the information in the pipe schedule shall take precedence.
- E. Coat the exterior of all piping in accordance with Section 09900.
- F. The work shall include, but not be limited to, the following:
 - 1. Connections to existing pipelines.
 - 2. Test excavations necessary to locate or verify existing pipe and appurtenances.
 - 3. Installation of all new pipe and materials required for a complete installation.
 - 4. Cleaning, testing and disinfecting as required.

1.2 RELATED WORK

- 1. Section 02669_ – Buried Process Pipe
- 2. Section 09900 – Painting
- 3. Section 15000 – Equipment General
- 4. Section 15100 – Valves

1.3 SUBMITTALS

- A. Submit all submittals in accordance with Section 01300, including:
 - 1. Layout Drawings including slope and high and low points
 - 2. Pipe and Valve Support Locations
 - 3. Pressure Test Reports
 - 4. Bacteriological (Bacty) Tests on potable water pipe

1.4 DELIVERY STORAGE AND PROTECTION

- A. Properly store, protect, and handle all pipe per manufacturer recommendations.

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- B. Store all plastic pipe indoors or cover until installed.

1.5 COORDINATION

- A. Inspect the contract documents before proceeding with installation of piping, etc. and determine that the location of the work does not interfere with other work. In case of interference, notify the Owner in writing. The Owner will then determine the resolution of the conflict and his decision shall be binding.
- B. Coordinate the elevations of cores, sleeves, pads, equipment connections, pump connections, etc. such that all pipe connections are properly aligned in vertical and horizontal planes.

1.6 REFERENCE STANDARDS

- A. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)
 - 1. MSS SP-58 – Pipe Hangers and Supports – Materials, Design and Manufacture
- B. NSF International (NSF)
 - 1. NSF 61: Drinking Water System Components
- C. American Water Works Association (AWWA)
 - 1. Various references as noted

PART 2 PRODUCTS

2.1 PIPING MATERIALS

- A. Various types of piping materials are used to meet the specific requirements of different piping systems as indicated in the “Piping Systems Schedule.” Follow this schedule. Where a particular piping material is chosen for a piping system, use that material alone throughout that entire system of pipe and fittings, unless noted otherwise on the drawings.
- B. Use NSF 61 compliant pipe, fittings, valves, gaskets and other appurtenances used for potable water applications.

2.2 ABOVE GRADE DUCTILE IRON PIPE (DI)

- A. Provide flanged joints or grooved joints for above grade pipe couplings. Provide flanged connections to valves or equipment unless otherwise indicated on the Drawings.
- B. Pipe Thickness
 - 1. Provide, at a minimum: Thickness Class 53 or Pressure Class 350.
- C. Linings
 - 1. Cement lining: conform to AWWA C104
 - 2. Glass Lining:

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- a. Glass-lined ductile iron pipe shall be furnished and installed where specified in the Piping System Schedule.
- b. Finished lining shall be from 0.008-inch to 0.012-inch thick, hardness of from 5 to 6 on the Mohs Scale, density of from 2.5 to 3.0 grams per cubic centimeter as measured in accordance with the requirements of ASTM D792 and be capable of withstanding a thermal shock of 350-degrees (F) without crazing, blistering, or spalling. The lining shall be Ervite Type SG-14, as manufactured by the Ervite Corporation, Erie, Pa., Ferroch MEH-32, by Water Works Supply & Mfg., Co., Marysville, CA., or equal.
- c. Cutting of glass-lined pipe in the field shall be limited to only one piece per run of pipe, and this shall be for closure purposes only. Spalling of the glass liner shall be no more than 1/8-inch back from the cut. Flanges and bolt holes on spool pieces shall be aligned prior to glassing and shall be sealed and tested prior to shipment in accordance with the manufacturer's recommendation. Warping of flanges and/or pipe may be cause for rejection as determined by the Engineer.

D. Flanged Pipe Couplings

1. Provide flanged joints which conforming with ASME B16.1 Class 150.
 - a. Non-Threaded mechanical flange fittings are not allowed.
 - b. Do not assemble flanges in the field.
2. Pipe: comply with AWWA C115
3. Fittings: comply with AWWA C110
4. Gaskets
 - a. Conform to AWWA C111
 - b. Provide full face gaskets, minimum 1/8-inch-thick as manufactured by Manville, Garlock or equal.
 - c. Gaskets for blind flanges shall cover the full face of the blind flange.
 - d. Sewage, wastewater, and sludge service:
 - 1) Styrene butadiene rubber (SBR)
 - e. Potable water service:
 - 1) Styrene Butadiene Rubber (SBR) or Neoprene.
 - 2) NSF 61 compliant
 - f. Air applications:
 - 1) EPDM or Grade L silicone rubber.
 - g. Digester gas applications:
 - 1) Buna-N.

E. Grooved Pipe Couplings

1. Couplings for ductile iron pipe
 - a. Victaulic Style 31 or engineer approved equal
 - b. Grooves cut for rigid joints.
 - c. For potable water service provide Grade M gaskets
 - d. For all other applications provide Grade S gaskets
2. Fittings for ductile iron pipe
 - a. Victaulic with rigid grooves
 - b. Conform to ANSI/AWWA C-606.
3. Couplings shall engage the grooved pipe around the entire circumference, and bolt together with two or more track head bolts.

4. Bolts and nuts shall be
 - a. General service: cadmium or zinc plated except
 - b. Headworks Facility, Wet well or corrosive service: 316 SS.

2.3 STEEL PIPE FOR HIGH PRESSURE SEWAGE

- A. Pipe 4-Inch Diameter and Larger:
 1. Seamless steel ASTM A106 Grades A, ASME B31.1. with Schedule 80 thickness.
- B. Pipe Joint Interior:
 1. Welded, ANSI flanged or grooved coupling in accordance with AWWA C606 (Victaulic Style 07) and shall be
 2. rated for 600 psi.
 3. Rigid, capable of transmitting both tensile and compressive load.
- C. Pipe Joint Exterior/Buried Joints.
 1. Shop welded joints per American Welding Society standards, field welded per AWWA C206.
 2. Re-coat field welded pipe as required
 3. Grooved couplings with Victaulic Style 77 flexible coupling where noted on the DRAWINGS at a minimum.
 4. At Contractor's option, all buried joints can be grooved coupling.
- D. Coat interior of pipes as follows:
 1. Surface Prep: SSPC-SP6
 2. Prime: Tnemec Series N69 3.0 – 5.0 mils
 3. Intermediate: Tnemec Series N69 4.0 – 6.0 mils
 4. Finish: Tnemec Series 1075 Endura Shield 2.0 – 3.0 mils
- E. Fittings:
 1. Seamless steel welded ASA B16.9.
 2. Coat in accordance with pipe coating requirements.
- F. Gaskets:
 1. For flanged joints: 1/8-inch-thick, Neoprene rubber.

2.4 STAINLESS STEEL PIPE (SS)

- A. Manufactured from ASTM-A240 annealed and pickled sheets and plates in accordance with ASTM A778 in type 304L stainless steel.
- B. Manufactured to nominal pipe sizes as listed in ASME B36.19, Table 1.
- C. Fittings: Butt weld type or grooved end manufactured in accordance with ASTM-A-774 of the same raw material and in the same thicknesses as the pipe.
 1. Long radius elbows up to 24" diameter: "smoothflow"; i.e. centerline to end of elbow equals 1.5 times the nominal pipe size.
 2. Short radius, special radius, and reducing elbows and long radius elbows greater than 24" diameter: mitered construction with at least:

- a. (5) miter sections for 90 degree bends,
- b. (3) mitered sections for 45 to 60 degree bends,
- c. (2) mitered sections for 30 degree and smaller bends.
- 3. Reducers: straight tapered cone type.
- 4. Shop fabricate tees, crosses, laterals and wyes from pipe.

- D. Finish on the raw material,
 - 1. Manufactured to ASTM A-20
 - 2. No. 1, HRAP (hot rolled annealed and pickled) or better.

- E. The finish on the completed pipe and fittings
 - 1. As specified in ASTM A778 and A774

- F. Flanged pipe ends
 - 1. Made up of type 304L stainless steel slip-on type rolled angle face rings and (primed or hot dipped galvanized) ductile iron back-up flanges drilled to ANSI 16.1 class 125 standard.
 - 2. Angle face ring thickness: equal to or greater than the wall of the pipe or fitting to which it is welded
 - 3. Attach angle face ring by a continuous welded on both sides to the pipe or fitting without interfering with the flange bolt holes.
 - 4. Provide back-up flanges with the following nominal thicknesses.

Nom. Pipe Size (in)	Flange Thickness (in)
2 1/2 - 3	1/2
4	9/16
6-10	5/8
12-16	3/4
8-20	7/8

- G. Arched band type couplings
 - 1. Stainless steel of equal superior alloy and wall thickness as the pipe
 - 2. Depend-O-Lok type as manufactured by Victaulic Brico or equal.
 - 3. Couplings: fixed type, expansion type, or fixed by expansion type as recommended by the coupling manufacturer to control expansion and contraction.
 - 4. Plain end with external weld beads ground smooth
 - 5. S.S. restraining rings shop welded to the piping for fixed type couplings.

- H. Grooved end pipe
 - 1. Stainless steel pipe may be grooved end in accordance with ANSI/AWWA C-606 at the contractor's option.
 - 2. Coupling: galvanized Victaulic Style 07 coupling
 - 3. Gaskets: grade E gaskets for liquid service; grade L silicone for air service.

2.5 STAINLESS STEEL TUBING AND FITTINGS (SST)

- A. Small diameter pneumatic and compressed air tubing
 - 1. Welded, Type 316 stainless steel meeting ASTM A269.
 - 2. Hardness: 80 Rb or less.

- B. Small diameter hydraulic tubing
 - 1. Seamless, drawn and annealed Type 316 stainless steel.
 - 2. Hardness: 80 Rb or less.
- C. Minimum pressure ratings are as follows:
 - 1. Pneumatic Lines - 200 psig
 - 2. Hydraulic Lines - 5000 psig (continuous service)
- D. Tubing diameters indicated on the drawings are minimum inside diameters (I.D.). Determine tubing outside diameters (O.D.) based on the following criteria:
 - 1. the pressure and temperature constraints for the application,
 - 2. the ultimate tensile strength,
 - 3. the minimum wall thickness required by ASME/ANSI B31.3.
- E. Tube fittings and ferrules
 - 1. Type 316 stainless steel free of scratches and suitable for bending and flaring.
 - 2. Threads: meet NPT specifications.
- F. Fittings:
 - 1. Swagelok as manufactured by Crawford Fitting Company or CPI fittings as manufactured by Parker Hannifin.

2.6 PLASTIC LINED PIPING

- A. Pipe and fittings:
 - 1. Flanged, lined steel piping
 - 2. Manufactured by Dow Chemical Company, Resistoflex, or Performance Plastic Products.
 - 3. Comply with ASTM F1545.
 - 4. Fittings: Schedule 40 steel or ductile iron completely lined to match connected piping.
- B. Lining:
 - 1. Polypropylene: lining minimum thickness of 0.125 inches with polypropylene conforming to ASTM D4101.
 - 2. Teflon: lining minimum thickness of 0.120 inches with Teflon conforming to ASTM D4894 and/or ASTM D4895

2.7 COPPER TUBING

- A. All copper tubing except as otherwise specified, shall be in conformity with the current ASTM Designation: B-88, "Seamless Copper Tube,"
 - 1. Type K soft temper for, buried and sealwater applications
 - 2. Type L hard temper for exposed applications.
 - 3. Provide flared joint fittings for annealed tubes.
 - a. Brass, SAE Type fittings with long nuts
 - b. Flared by proper flaring tools designed specifically for such joints
 - 4. Provide solder joint or mechanical press fittings for drawn temper tube.

- B. Solder joints
 - 1. Conform with the current ANSI B16.18: "Cast Brass Solder Joint Fittings."
 - 2. Solder: 95-5 tin antimony.
 - 3. Use only lead-free solder.
- C. Mechanical method for joining copper tubing
 - 1. May be used as an alternate to soldered joints
 - 2. Use for joining copper tubing with Type K or L or M copper tubing in sizes from ½" through 4".
 - 3. This method may be used for water service in the temperature range 0 deg. F to 250 deg. F and pressure range to 200 PSIG.
 - 4. Copper Press Fittings: conform with material and sizing requirements of ASME B16.18 or ASME B16.22.
 - 5. O-Rings: EPDM.
 - 6. Install the mechanical system using a tool intended specifically for pressing copper fittings.
- D. Mechanical press fitting system
 - 1. Provide Viega/Ridgid Copper press fittings assembled by the Viega/Ridgid Pro Press System or Elkhart Products Corporation Xpress Joining System.
- E. Push to connect fittings and valves for joining copper water tubing
 - 1. May be used as an alternate to solder joints
 - 2. Use for joining Type K, L, or M tubing, ½" through 2",
 - 3. EPDM seal
 - 4. 301 stainless steel internal components.
 - 5. PermaLynx as manufactured by Invent."

2.8 POLYVINYL CHLORIDE PIPE (PVC)

- A. Provide schedule 80 pipe and fittings for all PVC piping systems unless otherwise noted
- B. General Service PVC Piping
 - 1. Provide for all PVC pipe and fittings unless otherwise specified.
 - 2. Pipe: Class 12454 B
 - 3. Joints: socket welded or flanged, in accordance with the latest edition of ASTM D 1784 and D 1785. Provide pipe connections in conformance with the manufacturer's recommendations including supply of gaskets, where necessary.
 - 4. Provide schedule 40 pipe and fittings only where indicated on the Drawings.
 - 5. Provide Drain/Waste/Vent (DWV) Drainage fittings for all PVC drain lines
 - 6. Provide: "Chemtrol" as manufactured by Nibco, Inc., Plastiline, Inc., Harvel Plastics, Inc., Asahi America, Inc., R & G Sloane, or equal.
- C. For Chemical Service
 - 1. Solvent-welded joints with solvent cement per the pipe manufacturer's recommendations and in accordance with ASTM F493, "Solvent Cements for CPVC Plastic Pipe and Fittings,"
 - 2. Primer: in accordance with ASTM F656, "Primers for Use in Solvent Cement Joints of PVC Plastic Pipe and Fittings."

3. Provide Weld-On 724 solvent cement and Weld-On P-70 Primer as manufactured by IPS Corporation for all pipe joints.
 - a. Provide products with chemical resistance to sodium hypochlorite solutions.
4. Provide low-torque gaskets, full face to ANSI B16.5 dimensions with two raised convex molded rings concentric to the center hole and bolt circle.
 - a. Gasket material: EPDM durometer A, hardness 65-68, PTFE bonded EPDM or PVDF bonded EPDM.
 - b. Provide Low Torque AV Gaskets as manufactured by Ashai/America, Inc., Malden, MA, no substitutions.

2.9 CHLORINATED POLYVINYL CHLORIDE PIPE (CPVC)

- A. Pipe and fittings
 1. Schedule 80 unless otherwise indicated on the Drawings.
 2. Comply with ASTM F441/F441M and US Product Standard PS 21-70 as having same outside diameter as iron pipe.
 3. Provide pipe connections in conformance with the manufacturer's recommendations including supply of gaskets, where necessary.
 4. Temperature rating up to 210°F and manufactured with minimum of 2 percent of titanium oxide for ultraviolet protection.
- B. Provide fittings which match the associated pipe as follows:
 1. Solvent Welded: Fittings complying with ASTM F439 for socket type.
 2. Threaded: ASTM F437.
 3. Flanged: Flanged fittings with EPDM gaskets.
- C. Provide Joints as follows:
 1. Solvent Welded:
 - a. Use with solvent cement per the pipe manufacturer's recommendations and in accordance with ASTM F493, "Solvent Cements for CPVC Plastic Pipe and Fittings," and with
 - b. Primer in accordance with ASTM F656, "Primers for Use in Solvent Cement Joints of PVC Plastic Pipe and Fittings."
 - c. Weld-On 724 solvent cement and Weld-On P-70 Primer as manufactured by IPS Corporation for all pipe joints.
 2. Threaded:
 - a. Use female threaded fittings only for the purpose of coupling CPVC piping to threaded metallic pipe.
 - b. Threaded fittings larger than 2-inch in diameter is not acceptable.
 - c. Threaded piping of any size is not acceptable.
 - d. Use 100 percent virgin polytetrafluoroethylene (Teflon or PTFE) tape for threaded fittings.
 3. Flanged:
 - a. Provide with backup flanges minimum 1/8-inch thick Type 304 stainless steel.
 - b. Connecting bolts: Type 304 stainless steel.

2.10 POLYVINYL CHLORIDE PRESSURE TUBING (PVC-T)

- A. Reinforced flexible, clear tubing designed for high pressure applications.
 - 1. Reinforced with a white polyester cord embedded in the tube walls.
 - 2. Wall thickness: 3/32" minimum.
 - 3. Pressure rating: 160 psi minimum.
 - 4. Provide brass compression type fittings

2.11 FLANGED COUPLINGS ADAPTER (FCA)

- A. Slit Sleeve Couplings (Victaulic)
 - 1. Installed at locations indicated on the Drawings
 - 2. Bolted split sleeve type with one piece split housing, flanged sleeve, gasket assembly, end rings (for welding to pipe and flanged sleeve) and bolts and nuts for attachment of the split housing.
 - 3. ASTM A-36 carbon steel construction with double arch cross section split sleeve
 - 4. Buna N gasket
 - 5. Bolts and nuts: carbon steel ASTM A-325.
 - 6. Carbon steel end rings for field welding to the pipe and flanged sleeve.
 - 7. Designed to engage shoulders at the ends of the split sleeve and provide for restraint of the joint. Welding dimensions and specifications shall be in strict accordance with the coupling manufacturers recommendations.
 - 8. Manufactured by Victaulic or approved equal.
- B. Restrained Couplings
 - 1. ASTM A536 ductile iron construction with fusion bonded epoxy coating for the gasket ring.
 - 2. The restraining system shall consist of individually actuated gripping wedges with torque limiting actuating screws.
 - 3. Provide Series 2100 Megaflange manufactured by EBAA Iron, Inc

2.12 BOLTED FLEXIBLE COUPLINGS (BFC)

- A. Bolted flexible couplings on pressurized lines installed above grade
 - 1. Provide with restraining rods designed to resist the test pressure of the piping system in accordance with AWWA Steel Pipe Design Manual M11 and AWWA Ductile Iron Pipe Fittings M41.
 - 2. Gaskets: Nitrile
 - 3. Provide Style 38, Dresser Couplings or Smith-Blair 411 with NSF-61 approved gaskets, or equal.

2.13 DISMANTLING JOINTS

- 1. Restrained and rated for the pressure and service of the connected piping.
- 2. Provide with restraining rods designed to resist the test pressure of the piping system in accordance with AWWA Steel Pipe Design Manual M11 and AWWA Ductile Iron Pipe Fittings M41.
- 3. Provide Smith-Blair 975, Romac Industries DJ 400, or equal.

2.14 QUICK DISCONNECT FITTINGS

- A. Provide cam lock type, aluminum construction, male adapter by male NPT, Andrews Series F-AL as manufactured by Dixon Valve and Coupling Co. or Model 633-F as manufactured by Civacon.
 - 1. Connected to a threaded stainless steel flange suitable for bolting to the flanged pipe end.
 - 2. Equip each fitting with a cap of the camlock type, aluminum construction,
 - 3. Provide Andrews Series DC-AL or Civacon Model 634-B.
- B. Quick disconnect fittings for plastic piping
 - 1. Cam lock type, polypropylene construction, male adapter by male NPT, Series F as manufactured by Banjo Corporation.
 - 2. Connected to a threaded PVC flange suitable for bolting to flanged pipe end.
 - 3. The quick disconnect fitting shall be equipped with a cap of the camlock type, polypropylene construction, Banjo Series CAP.
- C. Quick disconnect diameter schedule:

Pipe Diameter	Quick Disconnect Diameter
≤6"	1½"
8"-12"	2"
16"-24"	3"

2.15 FLEXIBLE PIPE CONNECTORS

- A. Provide flexible connectors on inlet and outlet piping to pumps and air blowers and as shown on the Drawings.
 - 1. Construction: one-arch synthetic rubber with integral 150 lb. flanged ends.
 - 2. Temperature rating: up to 230° F at 65 psi.
 - 3. Provide: Mercer spool type 100 HT, Red Valve, Proco, or equal.

2.16 INSULATING COUPLINGS (PREVENTION OF ELECTROLYSIS)

- A. Provide at all joints between piping systems constructed of dissimilar metals.
 - 1. Pressure rating: match associated piping test pressure.
 - 2. Provide material suitable for the application and service.
 - 3. Provide insulating couplings manufactured by Romac, Smith-Blair, or equal.

2.17 WALL PIPE SLEEVES AND HYDROSTATIC SEALS

- A. Penetrations for pipes up to 24" passing through walls and floors of new structures
 - 1. Install molded non-metallic high-density polyethylene Model CS Century-Line® sleeves as manufactured by PSI-Thunderline/Link-Seal.
 - 2. Provide end caps manufactured of the same material as the sleeve itself. Install at each end of the sleeve so as to prevent deformation during the initial concrete pour, and to facilitate attaching the sleeve to the wall forms.
 - 3. Leave end caps in place to protect the opening from residual debris and rodent entry prior to pipe insertion.

: \ 2 0 1 9 0 3 \ 2 0 1 9 0 3 2 1 \ \ 0 4 - d e s i g n \ s u b m i t t a l s \ i f b - s u b m i t t a l \ s p e c s \ 1 5 0 6 0 e x p o s e d p r o c e s s i p i p e a n d f i t t i n g s 2 0 2 0 0 5 1 5 a n n o t a

- B. Penetrations for pipes passing through existing concrete or masonry walls
 - 1. Schedule 40 steel pipe,
 - 2. Either black steel, galvanized or stainless steel depending on the environment.
 - 3. Provide approved anchoring lugs.
 - 4. Provide sleeves of sufficient diameter to allow for pipe insulation and its jacketing, where insulation is required.
- C. Seal space between pipe and sleeves
 - 1. Provide modular seal rubber links of the mechanical type, consisting of inter-locking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening.
 - 2. Seal to provide air tightness for above ground installations and water tightness for below grade installations.
 - 3. Caulking or other type mastic sealants or lead oakum joints are not acceptable.
 - 4. Provide 316 stainless steel fasteners
 - 5. Provide seals as manufactured by PSI-Thunderline/Link-Seal.

2.18 BOLTS, STUDS, NUTS AND HARDWARE

- 1. Nuts: heavy hex nuts conforming to ASTM A563 grade A
- 2. Bolts and other hardware not specified elsewhere: low carbon steel conforming to ASTM A307, grade B
- 3. When joining flanged pipe coat all bolts with anti-seize compound prior to assembly.

2.19 PIPE SUPPORTS

- A. All pipe supports shall be constructed of 316 stainless steel, unless otherwise noted on the drawings.
- B. Support system
 - 1. Provide series "P" as manufactured by Aickin Strut Co. subsidiary of Robroy Industries, Verona, PA, or equal.
- C. "Unistrut" used to support piping
 - 1. Provide Series P1000, galvanized, as manufactured by the Unistrut Products Co., Super Strut A 1200, Power Strut PS 200, or equal.
- D. Clevis type pipe hangers
 - 1. Adjustable wrought steel.
 - 2. Provide Grinnel Figure No. 260, Fee and Mason Fig. 239, Carpenter and Patterson Fig. 100, or equal
 - 3. Complete with bolts, rods and nuts.
- E. Beam clamps
 - 1. Malleable iron with bolt, nut and pocket threaded for rod connection.
 - 2. Provide Grinnel Fig. 229, or Elcen Fig. 95.
- F. Adjustable roll stands
 - 1. Cast iron,
 - 2. For rod supported type provide Elcen Fig. 18, or Grinnel Fig. 177

3. For base supported type provide Elcen Fig. 20 or Grinnel Fig. 274
- G. Pipe saddles for insulated cold piping
 1. Provide Grinnel Fig. 167, Elcen Fig. 219 B Line systems Fig. B 315, or equal.
- H. Pipe Saddles for general service
 1. Provide Grinnel Series 160, F & S manufacturing Series 900, Elcen Series 251, B Line Systems Series 3160 or equal
 2. Size to accommodate specified insulation thickness.

PART 3 EXECUTION

3.1 INSTALLATION – GENERAL

- A. Install Pipe and Fittings according to manufacturer recommendations.
- B. Run pipe parallel with the lines of the building unless otherwise shown or noted on the drawings.
 1. Install all horizontal runs of piping shall be kept at least 7'-0" high so as to provide maximum head room.
 2. Keep vertical lines as close to the columns or walls as possible.
 3. Install pipe lines so as not to interfere with ducts, conduits, truss work or other trades and with approved offsets around columns, beams and other obstructions, and with necessary expansion joints, pipe bends or fitting offsets, as may be indicated on the shop drawings or required as essential to an approved installation.
- C. Ream all pipe ends. Take care at all times to prevent foreign material from entering any pipe.
- D. Make all threaded couplings using an approved Teflon tape. Take care to prevent the tape from reaching the pipe interior.
- E. Install all horizontal lines to pitch to low points to provide for complete drainage of each system.
 1. Pitch for general service: Not less than 1 inch in 40 feet against direction of flow.
 2. Pitch for hot water heating, gas and air lines: as stated above, but in direction of flow.
- F. Install air vents on all water and sewage lines at all high points and at locations where air may pocket.
 1. Drain air vents to floor, sump, sewers or suitable receivers with PVC pipe.
- G. Do not cut, burn or weld structural steel interfering with pipe installation to aid in installation except with written approval of the Owner.
- H. Disinfect water distribution system in accordance with AWWA C651.

3.2 COATED STEEL PIPE JOINTS

- A. Primed and tape joints per the coating manufacturer's recommendation.
 - 1. Handle piping with rope or burlap slings. Do not use metallic pipe handling equipment.
 - 2. Backfill trenches with sand. No stones shall be allowed in the backfill material.
 - 3. The pipe during manufacturing, upon delivery and after placement, shall be subject to inspection and testing.
 - 4. Provide coating as manufactured by Standard Pipe Protection or equal.

3.3 STEEL PIPE AND FITTINGS

- A. Perform field welding, where required, in accordance with the manufacturer's recommendations.
 - 1. Do not compromise coatings.

3.4 STEEL TUBING AND FITTINGS

- A. Install tube bends and fittings in compliance with the following table.
 - 1. The table indicates minimum radius for bends and the minimum length required between bends and fittings.

Tube O.D.	Minimum Radius (90°bend)	Minimum Length
3/8"	1"	3/4"
1/2"	1-1/2"	1"
5/8"	1-3/4"	1-1/4"
3/4"	2"	1-1/2"
7/8"	2-1/2"	1-1/2"
1"	3"	1-3/4"
1-1/4"	4"	2"
1-1/2"	4-1/2"	2-1/2"
2"	8"	3-1/2"

3.5 COPPER TUBING

- A. Provide solder joint type fittings in conformity with the current ANSI B16.18: "Cast Brass Solder Joint Fittings".
- B. Solder: 95 5 tin antimony. Use only lead-free solder.
- C. Flared joint type fittings:
 - 1. Brass construction SAE Type with long nuts.
 - 2. Flare tubing using proper flaring tools designed specifically for such joints.
- D. Install tubing level or plumb with 90°/45° bends.

3.6 SOLVENT WELDING OF PVC PIPE

- A. Solvent weld PVC piping in accordance with ASTM D2855

3.7 PIPING HANGERS AND SUPPORTS

A. General

1. Piping shall not introduce any strains or distortion to the connected equipment. The Engineer will direct the Contractor to remove any piping to verify zero strain.
2. Adequately support all piping by installing hangers and supports.
3. Carry overhead lines directly on supports or suspended by clevis hangers from supports.
4. Support piping at all equipment, control valves, etc., so that equipment, valves, etc., can be removed without compromising pipe support.
5. Support cantilevered pipe at couplings.
6. Provide additional support for valves installed in fiberglass and PVC pipelines as required.
7. All hangers and supports shall be capable of adjustment after installation. Types of hangers and supports shall be kept to a minimum.
8. Hanger rods shall be straight and vertical. Chain, wire, strap, or perforated bar hangers shall not be used. Hangers shall not be suspended from other piping.
9. Supports and hangers for plastic piping shall include wide saddles or bands as recommended by the manufacturer and approved by the Engineer to distribute load and thus avoid localized deformation of the pipe.
10. Hanger and supports shall prevent contact between dissimilar metals by use of copper plated, rubber, vinyl coated or stainless steel hangers.
11. Provide spacing of supports for horizontal piping no greater than that shown on the following schedule or as detailed on the drawings:

Steel Pipe	Support Spacing	Copper Pipe	Support Bracing
1/2" & smaller	7'-0"	1/2"	6'-0"
3/4" - 1"	8'-0"	3/4" - 1"	8'-0"
1-1/4" - 1-1/2"	9'-0"	1-1/2" - 2"	10'-0"
2"	10'-0"	2-1/2" - 5"	12'-0"
2-1/2" - 3-1/2"	12'-0"	6" & larger	14'-0"
4" - 5"	14'-0"		
6"	16'-0"		
8" - 12"	20'-0"		

Fiberglass Pipe	Support Spacing	PVC and Poly-Propylene Pipe	Support Bracing
2"	7'-0"	1/2" - 3/4"	3'-0"
3"	7'-6"	1" - 1-1/2"	3'-6"
4"	8'-0"	2"	4'-0"
6"	9'-0"	2-1/2" - 3"	4'-6"
8"	10'-0"	4"	5'-0"
10"	11'-0"	6"	6'-0"
12"	12'-0"		
14" & larger	13'-0"		

12. Cast iron and ductile iron pipe: Support at each joint or at 12'-0" maximum centers, whichever is closer.

: \ 2 0 1 9 0 3 \ 2 0 1 9 0 3 2 1 \ 0 4 - d e s i g n \ s u b m i t t a l s \ i f b - s u b m i t t a l \ s p e c s \ 1 5 0 6 0 e x p o s e d p r o c e s s i n g p i p e a n d f i t t i n g s 2 0 2 0 0 5 1 5 a n n o t a

13. Prior to installing fiberglass pipe, obtain the manufacturer's recommendations in writing for method and location of supports, guides and anchors.
14. Support hose and/or flexible tubing continuously in iron channel, or approved ladder racks.
15. Support risers at intermediate points as required for rigidity.
16. Support vertical piping at its base by a hanger placed in the horizontal line near the riser, or by a base fitting set on a pedestal or foundation.
17. For all fiberglass pipe, provide pipe protection shields or half pipe saddles at all hangers or supports.
18. Whenever possible, provide supports at tees, dresser/Victaulic style couplings and adjacent to valves.

B. Pipe Hangers

1. Size hanger rods used in conjunction with clevis hangers as indicated in the following schedule. Provide rods of cold rolled steel construction.

Pipe Size	Hanger Rod Dia.
1/2" - 2"	3/8"
2-1/2" - 3-1/2"	1/2"
4" - 5"	5/8"
6"	3/4"
8" - 12"	7/8"
14" -18"	1"

2. Trapeze hangers with U-Bolt type fastening may be used in lieu of clevis hangers in congested areas.
3. Connect hanger rods to beam clamps, concrete inserts, or expansion shields.
 - a. Provide Underwriter's Laboratories approved devices.
 - b. C-clamps are not allowed.
4. Perforated band iron or wire hangers shall not be used.
5. Provide wrought-steel riser clamps with extension lugs and suitable bolts and nuts.

C. Concrete Supports

1. Support ductile Iron and large diameter pipe by concrete supports when the exterior surface of the pipe is within 30" of the finished floor.
2. Concrete support details are shown on the drawings.
3. Place concrete supports according to the spacing listed above.

3.8 PIPE TAPS

- A. Provide pipe taps in the locations and the sizes indicated on the Drawings.
- B. Temporarily plug all taps at the point of fabrication.
 1. Tapping method and thread: meet the requirements of the pipe manufacturer
 2. Pressure rating: match pressure rating of the pipe.
- C. Install corporation stops, pipe saddles or other devices where required to facilitate installation of the connecting pipe.

1. Materials: compatible with environmental conditions, as well as liquid and pressure of the fluid in the pipeline.

3.9 UNIONS AND FLANGES

1. Provide unions at all valves up to 4" size, and at final connections to equipment, or apparatus.
2. Provide bolted flexible coupling, companion flange or grooved coupling for valves 4" and above.
3. Provide sufficient joints in piping systems to allow each system to be readily dismantled.
4. Materials: compatible with environmental conditions, as well as liquid and pressure of the fluid in the pipeline.
5. Do not install unions or companion flanges in walls, ceilings, partitions or other inaccessible locations.
6. Wherever flanges with raised faces are joined to companion flanges with a flat face, machine down the raised face to a smooth matching surface and provide a full-face gasket.

3.10 WALL PIPE SLEEVES, COVER PLATES & FLASHINGS

1. Furnish, locate and set all required wall pipe, pipe sleeves, flashings and plates for sections of the work where piping passes through floors, walls, ceilings or roof.
2. Where wall pipe and sleeves pass through new concrete construction, locate and set wall pipe and sleeves before concrete is poured.
3. Provide water stop at mid slab for wall pipe passing through walls or floors with water, earth or weather on one side.
4. Extend floor pipe sleeves a minimum of 2" above floor surface.
5. Provide escutcheon plates matching the room aesthetic, large enough to cover the pipe sleeves, for piping extending into finished areas of the building.

3.11 PIPING FOR GASEOUS FLUIDS

- A. Install dirt pockets with drain connections and a 3/4 in. gate valve in all lines, 3/4 in. and up, carrying gaseous fluids (such as natural gas, steam, compressed air, gases, etc.).
 1. On lines up to and including 2 in. diameter, the dirt pockets shall be equal to the line diameter and a minimum of 12 in. deep.
 2. On lines 2-1/2 in. through 12 in. diameter the dirt pockets shall be equal to 3/4 of the line diameter and a minimum of 18 in. deep.
 3. Install at:
 - a. All low points in the system.
 - b. Ahead of any rise in the piping.
 - c. At the end of every primary and secondary main.
 - d. Every 400 feet (maximum) of level piping with a relatively constant demand during design operation.
 - e. Every 200 feet (maximum) of level piping with considerable on and off demand during design operation.
 - f. Ahead of all pressure reducing and control valves unless the branch feeding the valve is taken off the top of the main and is 5 feet or less in length.

- B. Valve all compressed air, natural gas or other gaseous piping connections to equipment where practical.
 - 1. Pipe these connections back to the top of the main or sub main.

3.12 SOIL, WASTE, STORM AND VENT PIPES

- 1. Material: As acceptable for use in the applicable plumbing codes or as noted on the Drawings.
- 2. Size: Conform to the requirements of the plumbing code unless larger pipe sizes are shown on the drawings.
- 3. Vent and re-vent all fixtures as required to comply with the plumbing code, whether or not so indicated on the drawings.
- 4. Provide accessible cleanouts on all vents and foot conduits.

3.13 PIPE SADDLES AND INSULATION

- A. Provide pipe covering protection saddles for hot steel piping at roller supports and other places where required for the purpose of protecting the insulation at the pipe supports.
 - 1. Construction: Curved steel plates with the edges turned up, welded to pipe, and formed to fit the outside radius of the pipe covering.
 - 2. Fill each saddle with specified covering material after being welded to pipe
- B. Cover all insulated cold piping with a vapor barrier jacket support on saddles.
- C. Wood Blocking
 - 1. For installations where the supported weight of the pipe is sufficient to distort the pipe insulation with the shield in place, install hard wood blocking against the pipe.
 - 2. Thickness: same thickness as the insulation
 - 3. Paraffin coated.
 - 4. Provide B Line Systems Fig. B3169, Elcen Fig. 216 or equal.
 - 5. Install vapor barrier over the wood blocking to maintain the integrity of the system.

3.14 PRESSURE TESTS

- A. Perform pressure tests on all piping included in the contract.
- B. The testing requirements for the respective piping systems include all those of the applicable governing codes, such as state, local, and insurance, and those hereinafter specified.
 - 1. Provide all code required inspection certificates, as required.
- C. If there are no Laws and Regulations covering the test, use the test procedures described in the following standards:
 - 1. AWWA C600 for Ductile Iron Pipe
 - 2. AWWA C605 for Thermoplastic and Fiberglass Pipe
 - 3. ASTM F2164 for HDPE Pipe
- D. Test all piping before piping is painted, covered or concealed.

- E. Furnish all pumps, compressors, gauges and other necessary testing equipment and make all connections necessary for the tests. Provide all materials, equipment and labor necessary to perform these tests.
- F. Perform all tests in the presence of the Owner and, where required, the inspection department having jurisdiction.
- G. Replace and re-test all defective material identified by the tests. Repair piping with new material and to the satisfaction of the authorized inspectors.
- H. Test all piping systems hydrostatically at test pressures listed in the Pipe Schedule, unless specified elsewhere.
- I. If test pressure is not listed in the Pipe Schedule, or if a test is required for piping not listed in the Pipe Schedule, test pressure will be determined by the Engineer based on the maximum anticipated sustained operating pressure and the methods described in the applicable ANSI/AWWA manual or standard that applies to the piping system.
- J. Test Procedure
 1. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate not to exceed 1 foot of pipe length per second in pipe being tested.
 2. Expel air from pipe as required. Obtain approval of Engineer prior to tapping pipe for expelling air.
 3. Examine exposed joints and valves and make repairs to eliminate visible leakage.
 4. After specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
 5. For HDPE Pipe: After filling pipe, gradually pressurize pipe to test pressure and maintain required test pressure for three hours to allow for pipe to expand. During expansion, add fluid to maintain required test pressure. Begin timed test period after expansion period and other requirements are met.
 6. Begin timed test period only after pipe has been filled, exposed to required wetting period, air has been expelled, and pressure stabilized.
 7. During timed testing period maintain test pressure for at least 2 hours. Add fluid as required to maintain pressure within 5-psig of required test pressure.
 8. For HDPE pipe, after 3-hour expansion phase, reduce test pressure by 10-psig and do not add liquid. Test pressure shall then remain steady for 1 hour indicating no leakage.
 9. Pump from test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report.
 10. Record pressure at test pump at 15-minute intervals for duration of test.
- K. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within 5 psi of the test pressure during timed test period. Allowable leakage rates for piping are:
 1. No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.
 2. Allowable leakage rates for metal and fiberglass with rubber gaskets as sealing members, including the following joint types: bell and spigot and push-on joints,

: \ 2
0 1
9 9
0 0
3 3
\
2 2
0 1
1 9
9 0
3 3
2 2
1 1
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0 0
4 4
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d e
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i p
e a
n d
f i
t t
i n
g s
2 2
0 2
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5 1
1 5
a n
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d o
c

Mechanical joints, bolted sleeve type couplings, grooved and shouldered couplings and thermoplastic pipe joined with O-ring gasket sealing members is provided as follows:

$$L = \frac{SD\sqrt{P}}{148,000}$$

Where:

L = allowable leakage in gallons per hour

S = length of pipe tested in feet

D = nominal diameter of the pipe in inches

P = average test pressure during the test, in psig

* For pipes tested with varying diameter sections, the allowable leakage rate shall be the sum of the computed leakage for each section of pipe diameter

3.15 GRAVITY PIPE LEAK TESTING

- A. Test all gravity pipes in accordance with ASTM C969 and C1244.
- B. Plug and bulkhead ends and lateral connections of pipe segment to be tested and admit fluid until the pipe is full. Admit fluid slowly to minimize air entrapment.
- C. Before measuring leakage, allow fluid to wet pipe interior for the following period:
 1. Concrete Pipe: 48 hours.
 2. Cement Mortar-lined Pipe: 24 hours.
 3. Other Pipe: Wetting period not required.
- D. Provide a minimum hydrostatic head during test of 2 feet above highest point of pipe segment tested. Add fluid from a test container or from a metered supply as required to maintain the test water level within 3 inches of the test head throughout the test.
 1. Test duration: at least 2 hours.
- E. Leakage is defined as the quantity of fluid that must be supplied to pipe segment tested to maintain the hydrostatic head within 3 inches of test head during the test after pipe has been filled and exposed to required wetting period, plus the quantity required to refill to original head at end of test.

3.16 LOW PRESSURE AIR AND PROCESS AIR PIPE TESTING

1. Required test pressure is listed in the Pipe Schedule.
2. Provide temporary tie rods at expansion joints as required. Verify that pipe supports, where present, are secure. Test one pipe segment at a time. Use temporary blind flanges and isolators as required. Install corporation cocks for filling and relieving air. Provide temporary automatic pressure relief valve and pressure gauge with range suitable for test pressure.
3. Pressurize pipe segment being tested with air to the required test pressure. Maintain pressure for at least 2 hours. Apply a soapy water solution to all joints to check for leakage, indicated by presence of bubbles, while test pressure is maintained.
4. Allowable Leakage: Zero
5. Repair and retest pipelines that fail the test.
6. After testing is complete, remove temporary measures provided for testing and provide Type 304 stainless steel threaded plugs at taps used for testing.

PRESSURE TEST REPORT FORM

Project:	Date:
Contractor:	M T W TH F S
Owner:	Job No.:
Test Location:	Report No.:

GENERAL

System to Be Tested: _____

Location of Pipe: _____

Type of Pipe Material: DI/CI Steel Cu PVC HDPE Other ____

Length of Pipe Tested: _____ feet

SPECIFICATION

Type of Test: Hydrostatic Pneumatic Other _____

Bacteriological Test Required?: Yes No

Duration of Test: _____ hours

Test Pressure: _____ psi

Pressure / Gallons Loss Allowed: _____ psi/gallons

TEST DATA

	<u>Pressure</u>	<u>Time</u>
Start of Test:	_____ psi	_____ AM / PM

Completion of Test:	_____ psi	_____ AM / PM
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Pressure / Gallons Lost at Finish: _____ psi/gallon

Results: Pass Fail

SYSTEM TEST PERFORMED BY:

 Contractor Date

WITNESSED BY:

 Engineer Date

ACCEPTED BY:

 Owner Date

END OF SECTION

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SECTION 15100

VALVES AND ACTUATORS

PART 1 GENERAL

1.1 SUMMARY OF WORK

- A. Furnish all labor, materials, tools, equipment, and supervision required to complete all valve installations as indicated on the drawings and specified herein, and all other work incidental thereto, except as otherwise noted.
- B. Supply valves per the valve schedule contained herein, or as shown on the Drawings.

1.2 ITEMS SPECIFIED ELSEWHERE

- A. Section 01300 – Submittals including Shop Drawings
- B. Section 01730 – Operation and Maintenance Manuals.
- C. Section 09900 - Painting.
- D. Section 15000 - General Mechanical Provisions.
- E. Section 15060 - Pipe & Pipe Fittings.
- F. Section 01600 – Materials and Equipment

1.3 SYSTEM DESCRIPTION

- A. Valves and operators shall be of the type and size indicated on the Valve Schedule shown on the Drawings or included herein.
- B. Valves and actuators shall be factory assembled by the valve manufacturer.

1.4 SUBMITTALS

- A. Shop drawings
- B. O&M Manuals
- C. Actuator Warranties
- D. Wiring Diagrams

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1.5 WARRANTY

- A. The warranty period for all items covered by this Section of the Specifications, except electric actuators, shall be one year from the date of equipment acceptance as specified in the General Conditions. Electric actuators shall be warranted against defects in workmanship and material as specified hereinafter.

1.6 STORAGE OF MATERIAL

- A. All material shall be stored prior to installation in accordance with Division 1, and the manufacturer's instructions. Valve actuators shall be stored in a manner to prevent damage due to moisture or water intrusion.
- B. Conduits connected to valve actuators shall be temporarily sealed during construction to prevent water entrance through open conduit systems.

PART 2 PRODUCTS

2.1 GATE VALVES

- A. Type G-1(Resilient Wedge)
 - 1. Gate valves shall be of the non-rising stem, ductile iron body, resilient wedge type, minimum 150 psi water working pressure and shall conform to AWWA C-509 or C515. Valves shall include ends (flanged, Victaulic or mechanical joint as shown on drawings or elsewhere in the specifications), a ductile iron wedge encapsulated with a resilient elastomer material, cast bronze stem and nut, and Delrin thrust bearing. The stem seal plate shall include an O-ring gasket to seal against the bonnet. The stem seal shall be replaceable with the valve under pressure and full open. The body, bonnet, and seal plate shall have a factory applied fusion bonded epoxy coating on all interior and exterior surfaces. The coating shall comply with AWWA C-550-81. The valve body shall be free of pockets or ledges where sediment or debris can collect.
 - 2. Valve actuators shall be as indicated in the valve schedule. Motorized valves shall be equipped with a mounting yoke and stem coupling suitable for connection of the motor actuator.
 - 3. For buried service, valves shall be supplied with cast iron slide extension type valve boxes, with flanged cover. Extension stems shall be 304 stainless steel with 2" sq. C.I. operating nuts. All exposed bolts, nuts and hardware for buried valves shall be of stainless steel construction.
 - 4. Valves shall be Series 2500 as manufactured by American Flow Control division of American Cast Iron Pipe Co. or US Pipe Metroseal.
- B. Type G-2 (Rising Stem)
 - 1. Gate valves 4" and larger shall be flanged end, rising stem, cast iron, solid wedge, bronze trim and seat, gate valves with an outside screw and yoke. Valves shall be Crane No. 465-1/2, Jenkins 651-C, or equal.
 - 2. Above grade gate valves for potable water, compressed air, industrial water, non-potable water, effluent water, etc. 3" dia. and smaller shall be screwed type, 125 lb. bronze with solid wedge disc, Crane Model 428, Jenkins Model 47C, Stockham Model B-105 or equal.

C. Type G-3 (Non-Rising Stem)

1. Gate valves 4" and larger shall be flanged, non-rising stem, cast iron, solid wedge, bronze trim and seats, Crane No. 461, Jenkins No. 326C, or equal.
2. For buried service, valves shall be supplied with cast iron slide extension type valve boxes, with flanged cover. Extension stems shall be 304 stainless steel with 2" sq. C.I. operating nuts. All exposed bolts, nuts and hardware for buried valves shall be of stainless steel construction.

2.2 PLUG VALVES

A. Type P-1R (Reduced Port)

1. Reduced port plug valves 4" dia. and larger shall be flanged, plug valves smaller than 4" in dia. shall have screwed joints. All plug valves shall be eccentric type, non-lubricated valves with resilient faced plugs. Flanged valves shall be faced and drilled to the ANSI 125/150 lb. standard.
2. Valve bodies and plugs shall be semi-steel, cast or ductile iron. All exposed nuts, bolts, springs, washers, etc., shall be zinc plated. Adjusting and packing hardware shall be stainless steel. Resilient plug facings shall be Buna-N or other elastomer as required by the application.
3. The valve packing shall be adjustable and replaceable, consisting of multiple vee-rings and shall be visible, allowing service without removing the actuator.
4. The valve seat shall be welded nickel with a nominal thickness of 1/8". The valve shall incorporate upper and lower stainless steel bushings with grit excluders.
5. Valve pressure rating shall be 150 psi and shall be established by hydrostatic tests as specified by the current edition of ANSI Standard B16-1. Valves shall provide drip-tight shutoff up to the full pressure rating. Valves shall be capable of providing drip-tight shutoff up to the full rating with pressure in either direction.
6. Valves shall be DeZurik, Val-Matic, Victaulic, Henry Pratt, Milliken Co., or equal.

B. Type P-1F (Full Port)

1. Full port plug valves 4" dia. and larger shall be flanged, plug valves smaller than 4" in dia. shall have screwed joints. All plug valves shall be eccentric type, non-lubricated valves with resilient faced plugs and 100% flow area equivalent to adjoining pipe. Flanged valves shall be faced and drilled to the ANSI 125/150 lb. standard.
2. Valve bodies and plugs shall be semi-steel, cast or ductile iron. All exposed nuts, bolts, springs, washers, etc., shall be zinc plated. Resilient plug facings shall be Buna-N or other elastomer as required by the application.
3. The valve packing shall be adjustable and replaceable, consisting of multiple vee-rings or U-cup design and shall be visible, allowing service without removing the actuator.
4. The valve seat shall be welded nickel with a nominal thickness of 1/8". The valve shall incorporate upper and lower stainless steel bushings with grit excluders.
5. Valve pressure rating shall be 150 psi and shall be established by hydrostatic tests as specified by the current edition of ANSI Standard B16 1. Valves shall provide drip tight shutoff up to the full pressure rating with pressure in either direction.
6. Valve operators, regardless of the type, shall be mounted by the valve manufacturer and tested as an assembly at the factory of origin. Test documents shall be furnished upon request.
7. Valves shall be DeZurik Style PEF or Val-Matic Series 5800R

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- C. Type P-2 (Stainless Steel)
 - 1. Plug valves for digester gas service shall be of the non-lubricated type, 150 lb., carbon steel body, 316 stainless steel plug, and Teflon seats. Valves shall be gas tight in either direction up to a pressure of 125 psig.
 - 2. Valves 3” and larger shall be flanged and valves 2” and smaller shall have screwed ends.
 - 3. Valves shall be Permaseal Plug Valves as manufactured by DeZurik or SleeveLine Plug Valves as manufactured by Flowserve-Durco.
- D. Type P-3 (3-Way)
 - 1. Plug valve shall be three-way type with two ports always open. Valve shall be non-lubricated tapered plug type with flanged ends, cast iron body, hard rubber lining orepoxy coated, and hard rubber plug facing. The valve shall be equipped with a handwheel and gear actuator or other actuator as indicated in the valve schedule.
 - 2. Plug valves shall be style PTW with combination No. 1 flow pattern as manufactured by DeZurik.

2.3 CHECK VALVES

- A. Type C-1(Outside Lever & Spring)
 - 1. Outside lever and spring check valves 6" and larger shall be flanged, 125 psig, swing type. Valves shall have ductile iron bodies and discs, stainless steel disc shaft and Buna-N disc seat. Valves shall be complete with outside lever and spring suitable for vertical or horizontal service and shall be Golden Anderson Figure 230.
 - 2. Check valves 2” to 6” in size shall be flanged, 125 psig, swing type, ductile iron body and disc complete with outside lever and weight. Discs shall be Buna-N faced. Valves shall be suitable for vertical or horizontal service. Valves shall be Golden Anderson Figure 220, or Crispin series SWL-LW.
- B. Type C-2 (Outside Lever &Weight with Air Cushion)
 - 1. Outside lever and weight check valves shall be rubber seated, cast-iron body and disc complete with outside lever and weight and external air cushion chamber. The adjustable counterweight shall initiate valve closure and the air cushion chamber shall dampen valve closure to prevent slamming.
 - 2. All relevant provisions for valve type C-1 apply.
- C. Type C-3 (Rubber Flapper)
 - 1. Check valves shall be flanged, rubber flap, swing type, conforming to AWWA C508. The valve body shall have full flow equal to nominal pipe diameter and a 45 degree seating surface to provide a non-slam characteristic.
 - 2. Valve body and cover shall be ASTM A536, Grade 65-45-12, Class B Ductile Iron with O-ring face. The disc shall be steel-reinforced Buna-N conforming to ASTM D2000. Valve shall be suitable for potable water service and the interiors and exteriors shall be coated with an ANSI/NSF 61 approved epoxy or two part liquid epoxy.
 - 3. The valve shall be Crispin “RF Series”, Val-Matic 500 Swing-Check, or approved equal.
- D. Type C-4 (Swing Check)

1. Swing check valves for potable water, compressed air, industrial water, non-potable water, effluent water, etc. 3" diameter and smaller shall be screwed, regrindable swing type, 200 lb. bronze, Hammond IB944, Stockham Model B-345 or equal.
- E. Type C-5 (Lift Check)
1. Lift check valve for air compressor discharge shall be Hammond IB948 or equal with screwed connections.
- F. Type C-6 (Ball Check, Small Diameter PVC and Plastic)
1. Ball check valves for PVC piping systems shall be of polyvinyl chloride construction, 150 psi rating, screwed union body with socket weld ends and Viton "O" ring seals (or material suitable for chemical service). Valves shall be as manufactured by Nibco, Hayward, Asahi-America, or Colonial Valve.
- G. Type C-7 (Ball Check, Large Diameter)
1. Ball check valves 2" and larger for sewage and storm water service shall be flanged, 125 psig, ball type. The valves shall be suitable for vertical or horizontal service, as indicated on the Drawings, and shall be constructed with a ductile iron housing and cover, conforming to ASTM A 536. The cover O-ring shall be made from Buna, and the ball shall be hollow aluminum filled with foundry sand and coated with Buna material. The ball shall be concentrically weighted, so it will constantly rotate in the housing to clean itself automatically. The valve bolting shall be Zinc-coated steel and the connections shall be ASA 125# flanges.
 2. The valve shall be designed for a maximum working pressure of 145 PSI and a maximum temperature of 176°F.
 3. Valves shall be HDL Type 5087 as manufactured by HDL, Inc.
- H. Type C-8 (Slip-on Duckbill)
1. Duckbill check valves type C-8 shall be of rubber construction suitable for raw sewage and storm water service with inlet port area equal to inlet pipe area. The port area shall contour down to a duckbill which shall allow flow in one direction. Valve shall open when the internal pressure exceeds external pressure by 3" of water column. The flexible duckbill shall be of one piece rubber construction with inlet end designed to fit over ductile iron piping. Exterior of the duckbill shall be wrapped with minimum 1/8" thick EPDM.
 2. Check valves shall be Red Valve Tideflex.
- I. Type C-9 (Duckbill for Concrete Pipe)
1. Check valves type C-9 shall be identical to type C-8 except the valve shall be designed to fit over concrete pipe.
- J. Type C-10 (Duckbill for Flanged Pipe)
1. Check valves type C-10 shall be identical to type C-8 except that the valve shall be suitable for mounting to a flanged pipe. Valves shall be Red Valve Series 35 or Proco Style 710.
- K. Type C-11 (Silent Check)
1. Silent check valves shall be fully automatic spring loaded with ductile iron flanged globe style bodies. The spring shall be ASTM A313 stainless steel. The plug shall be 316 Stainless Steel and replaceable. Seats shall be Buna-N. The spring loaded valve

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- plug shall be center guided at both ends with a continuous integral stainless steel shaft. The flow area through the body shall be 10% greater than the equivalent pipe size.
2. Valves shall be GC Series as manufactured by Crispin Valve, Series 600 as manufactured by APCO, Series 1800 as manufactured by Val-Matic, GA Industries Fig 280, or approved alternate.

L. Type C-12 (Wafer Check)

1. Provide dual-vane wafer style check valves for air blower discharge service.
2. Valves shall have ductile iron 150 lb. ANSI wafer style bodies with stainless steel vanes and springs.
3. Valves shall be Crane Duo Check II, or equal.

2.4 BALL VALVES

A. Type B-1 (Corrosive Service)

1. Ball valves for sodium hypochlorite service shall be flanged with reinforced fiberglass polysulfane body and ball, fiberglass lever and TFE seats and seals. The valve stem shall be of the same construction as the body molded around a Hastelloy "C" insert. The valve gland shall be of Hastelloy "C" construction with Hastelloy "C" attachment bolts.
2. Valves shall be Nil-Cor 410 as manufactured by Dresser Industries.

B. Type B-2 (Chemical Service)

1. Ball valves for chemical services as indicated in the valve schedule shall be flanged with reinforced fiberglass vinyl ester body and ball, fiberglass lever and TFE seats and seals. The valve system shall be of the same construction as the body molded around a Hastelloy "C" insert. The valve gland shall be of the Hastelloy "C" construction with stainless steel attachment bolts.
2. Valves shall be Nil-Cor 310 as manufactured by Dresser Industries.

C. Type B-3 (Small Diameter)

1. Valves 2" and below shall be 316 S.S. body, ball and stem with Teflon seats and seals. The ball shall be full port, self-aligning with seats on both sides to provide a positive seal in either direction. The valve shall have a three-piece body with stainless steel body bolts, screwed ends. Valves shall be Model T-595-S6-R-66 as manufactured by Nibco, Apollo model 86R-100, or equal as manufactured by Watts or Nelles-Jamesbury.
2. Valves larger than 2" shall be 316 S.S. body, ball and stem with Teflon seats and seals. Valves shall be split body, full bore, class 150 design with flanged ends. Valves shall be Apollo model 87A-200, or equal as manufactured by Watts or Nelles-Jamesbury.

D. Type B-4 (PVC)

1. Ball valves for plastic piping systems shall be true union type constructed from PVC Type I, cell classification 12454, conforming to ASTM D-1784. Valves shall be equipped with double unions, TFE or PTFE seats, Viton O-rings, polypropylene or PVC handle and double block seal carrier designed to stop flow in either direction and allow safe removal of the downstream union. Valve end connections shall be socket welded or flanged. Valves shall be as manufactured by Spears Manufacturing Co., Nibco, Asahi America, or Colonial Valve.

- E. Type B-5 (Water and Compressed Air Service)
 - 1. Ball valves for water and compressed air service shall be 150 psi rated with threaded ends, two piece bronze body, brass ball and stem, PTFE seat ring and packing. The stem shall be of blowout proof design with adjustable packing.
 - 2. Valves shall be Crane Figure No. 9302 or equal.

2.5 BUTTERFLY VALVES

- A. Type BF-F (Flanged)
 - 1. Butterfly valves shall be of the flanged type conforming to AWWA C-504, Class 150 B requirements.
 - 2. Valve body shall be ASTM A-126 Class B cast iron. Valve disc shall be ASTM A-48 Class 40 C cast iron or ASTM A-536 grade 65-45-12 ductile iron.
 - 3. Seat material shall be Buna-N with stainless steel shaft, permanently self-lubricated non-metallic bushings and self-adjusting seal.
 - 4. Valves 12" or greater shall have field replaceable seats and shaft seals.
 - 5. Valves shall be as manufactured by DeZurik, Pratt, Val-Matic, Milliken, or Crispin.
- B. Type BF-W (Wafer)
 - 1. Butterfly valves shall be of the wafer type design, rated for 20 psi shut-off with Buna-N seats for liquid service or EDPM seats for air service. Shafts shall be one-piece stainless steel. All other conditions for BF-F shall apply to BF-W.
 - 2. Valves shall be Demco Series NE, ITT Grinnel Series 8000, DeZurik BRS or equal.
- C. Type BF-L (Lug)
 - 1. Butterfly valves shall be of the lug-style design. All other conditions from BF-F shall apply to BF-L.

2.6 GLOBE VALVES

- A. Type GL-1
 - 1. Globe valves for potable water, compressed air, industrial water, non-potable water, effluent water, etc. 3" dia. and smaller shall be screwed type, 150 lb. bronze with composition disc.
 - 2. Valves shall be Crane Model 7TF, Jenkins Model 106B, Stockham Model B-22T or equal.
- B. Type GL-2
 - 1. Globe valve shall be plug disc type, 316 SS construction, FPT with metal to metal seats, outside screw and yoke, bolted bonnet and Teflon packing.
 - 2. Valves shall be as manufactured by Crane, Powell, or equal.
- C. Type GL-3
 - 1. Globe valves shall be single seated, line pressure operated, diaphragm actuated, pilot controlled globe valves. Each valve shall seal by means of a corrosion resistant seat and resilient, rectangular seat disc. These and other valve parts shall be replaceable in the field, all such service and adjustments shall be possible without removing the valve from the line. The stem of each valve shall be guided top and bottom by integral bushings. Each valve and its pilot control system shall contain no packing glands or stuffing boxes. Diaphragms shall not be used as a seating surface, nor shall

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pistons be used as an operating medium. All internal and external ferrous surfaces shall be coated with a high quality, two part epoxy primer; valve exteriors shall then receive a coat of baked enamel paint.

2. Valve bodies shall be flanged, cast iron, 125 psi, ANSI B16.1 with stainless steel trim. Diaphragms, O-rings and seat disc shall be Buna-N.
3. The pilot control system shall consist of an explosion proof, normally closed 2 way solenoid pilot valve, an ejector, a "Y" strainer and an adjustable 2 way needle valve for opening and closing speed control. In addition, a check valve and appropriate pilot piping shall be provided to facilitate venting and draining of the pilot piping when the system is drained. External pilot control piping shall be designed and installed such that the hydraulic source for opening and closing the valve is derived from a remote location upstream of and the valve rather than the valve body as shown on the Contract Drawings. External pilot control piping shall be stainless steel.
4. The solenoid valve shall be suitable for 120 volt power supply and shall be equipped with a submersible and explosion proof NEMA Type 7 enclosure. Solenoid valve body shall be stainless steel. To isolate the control system from the main valve and system piping inlet and outlet ball stop valves shall be provided. Solenoid valves shall be capable of manual operation.
5. Each valve shall be designed to operate in an inverted position as shown on the Contract Drawings. The complete valve body including the bonnet area, internal cavities, and pilot piping shall automatically drain when the valve receives a signal to close.
6. Each valve, with appropriate pilot in place, shall be operationally and hydrostatically tested prior to shipping. Remote piping necessary for completion of the installation in the field shall be provided by the valve manufacturer.
7. Valves shall be furnished with open and closed position switches mounted on the valves stem and adjustable to show full closed and open positions.
8. Valves shall be Model 115-2 as manufactured by OCV Control Valves or Model 136-01 as manufactured by Cla-Val Co.

2.7 Solenoid Valves

A. Type S-1

1. Solenoid valves shall be 3/4" size, 120 Volt, Nema 4 (or Nema 7, location dependent), normally closed, with forged brass body, and Buna N seat, designed for slow closing action and manual activation.
2. Valves shall be Asco Catalog No. 8221G5EFMO.

2.8 PRESSURE RELIEF VALVES

A. Type PR-1

1. Pressure relief valves shall be of the single seated balance type bronze angle body with threaded inlet and outlet ports and stainless steel stem.
2. Valves shall be diaphragm operated, spring loaded with an adjustment range of 30 psi. Relief pressure setting shall be as specified in the Package Equipment Section of the specifications or as indicated on the Drawings.
3. Valves shall be Figure 6600-D as manufactured by Golden Anderson Industries.

2.9 MUD VALVES

A. Type MV-1

1. Mud valves shall be of all stainless steel construction, flange mounted, with neoprene or Buna-n seal and complete with extension stem, stem guide and handwheel actuator. The valve actuator shall include provisions for locking the operator in the close position.
2. Mud valves shall be Series 85 as manufactured by H. Fontaine Ltd., Trumbull Industries, or approved equal.

2.10 -GATE AND VALVE OPERATORS

A. Level Operators (L)

1. Lever operators shall be provided, as indicated in the "Valve and/or Gate Schedule".
2. Lever operators shall be of suitable length and material for the operation of the valve by one man with a pull of not more than 30 lbs.

B. Gear Operators (G)

1. Gear operators shall be provided, as indicated in the Valve Schedule. The gear mechanism shall be the totally enclosed type. The gear operator shall be selected to operate the valve at the indicated test pressure on the Piping Schedule with an operator pull of no more than 40 lbs. Gear operators for buried or submerged valves shall be sealed and specifically designed for buried/submersed service as indicated on the Drawings.

C. Handwheel Operators (HW)

1. Handwheel operators shall be provided as indicated in the Valve Schedule and shall be of the valve manufacturer's standard design. Handwheels shall operate with 40 lbs. maximum applied force, with the test pressure indicated on the Piping Schedule applied across the valve.

D. Chainwheel Operators (CW)

1. Valves shall be provided with chainwheel operators wherever indicated and where valve operator centerlines are installed higher than 6'0" above the floor.
2. Chainwheel operators shall be provided with stainless steel chains.

E. Electric Actuators (EM, EMR, EMS, EMX)

1. General
 - a. Valves or gates where called for on the Drawings or indicated in the valve and/or Gate Schedule, shall be furnished with electric motor operators. Each motorized operator shall consist of a motor operator, unit gearing, limit contacts, torque switches, terminal strips, gear case, stem nut, stem cover, control cabinet, reversing magnetic starter, push button control, indicator lights, shop wiring, and all other accessories required to provide satisfactory operation. A handwheel for operation in case of power failure shall also be provided. Valve operators shall be sized to guarantee valve closure at the specified differential pressure. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal. The time to operate any valve from full open to full closed shall not exceed 2

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- minutes for quarter turn valves, or the operating speed shall be not less than 12"/min. for gates.
- b. Each valve operator shall be designed to operate the valve from and/or to any intermediate position and shall be of sufficient size and rating to open and close the valve under any condition of operation.
 - c. Two sets of limit contacts shall be provided for remote indication of valve or gate position (open, closed). Two field programmable contacts and auxiliary contacts for monitor relay shall be included.
 - d. Each operator housing shall be of ductile iron or die cast aluminum construction. Unless specified otherwise herein, power to each operator shall be 460 V, 3 phase, 60 Hz., and all electrical enclosures shall be:
 - 1) NEMA Type 4 watertight (operator type EM), suitable for outdoor installation,
 - 2) NEMA 6 submersible (operator type EMS), suitable for occasional submergence at a depth of 21 feet for 72 hours, or
 - 3) NEMA Type 7 explosion proof (operator type EMX) as indicated in the valve schedule.
 - 4) NEMA Type-4 (operator type EMR), 120 volt, single phase, 60 Hz
 - e. Modulating Service
 - 1) When modulating service is specified, the actuator shall respond to a control signal as indicated on the Drawings. The package shall include an electromechanical reversing starter, control transformer, local controls, indicating lights and position indicator. Valve shall be capable of being stopped in any intermediate position.
 - 2) The operator shall be rated for at least 60 starts per hour, and a minimum accuracy of plus or minus one percent.
 - f. Quarter Turn Movement
 - 1) Valves 8" diameter and larger which require 90° movement (quarter turn valves) shall be provided with Model IQ/90° worm gear, AWWA C504 valve actuators, as manufactured by Rotork, EIM Series 2000, or AUMA Model SG (gear actuators shall be suitable for occasional submergence when used with actuators designed for submergence as indicated in the valve schedule).
 - 2) Valves 6" diameter and smaller which require 90° movement (quarter turn valves) shall be provided with Model IQT, as manufactured by Rotork, EIM Series 2000, or AUMA Model SG. Power to these actuators shall be 120V, single phase. All other requirements previously noted regarding service and duty ratings in paragraph 2.16 E.1.d shall apply to these actuators.
 - g. Multiple Turn Movement
 - 1) Valves which require multiple turn movement shall be provided with Model IQ/Bevel Gear valve actuators, as manufactured by Rotork, EIM Series 2000, or AUMA Model SA.
 - 2) In all other respects, all requirements of paragraph 2.21 E.1.d shall apply to these actuators.
 - h. Warranty
 - 1) Electric actuators shall be warranted against defects in workmanship and material for a period of five (5) years from the date of acceptance.

F. Gate and Valve Operator Accessories

1. General
 - a. Where indicated in the valve schedule and/or on the Drawings, extension stems with bronze bushed stem guides spaced as required, floorstands, valve boxes, gearing, handwheel, chainwheels and chains, lever, etc., shall be provided. Valve operator accessories shall be as follows:
 - Extension Stems - Type 304 S.S.
 - Couplings - Bronze or Stainless Steel
 - Chains - Stainless Steel
 - Valve Boxes - C.I. with 8" clear opening and removable cover
 - Operating Nuts - 2" square cast iron
2. Floorstands
 - a. Valves shall be provided with floorstands whenever indicated in the valve schedule or on the Drawings.
 - b. Floorstands shall be hot-dipped galvanized or stainless steel depending on the environment, see valve schedule or Drawings.
 - c. Manually operated floor stands will be right angle crank or handwheel type as indicated in Section 01600, the valve schedule or called for on the drawings. Each floor stand shall be provided with a threaded stem. Tapered roller bearings or ball bearings shall be provided above and below a flange on the operating nut to support both opening and closing thrusts. Bench stands shall operate under the specified operating head with not greater than a 40 lb. pull on the crank or handwheel. Gears shall be steel with machine cut teeth. The pinion shafts shall be supported on tapered bearings. All components shall be totally enclosed in a cast iron case and cover. Positive mechanical seals shall be provided on the operating nut to exclude moisture and dirt and prevent leakage of lubricant. Lubricating fittings shall be provided for the lubrication of all bearings.
 - d. Removable cranks and handwheels shall be designed for rough treatment and minimum weight. An arrow with the word "open" shall be permanently attached or cast on the floor stand indicating the direction of rotation to open the gate.
 - e. Limit Switches (LS) Limit switches shall be provided on valves as indicated in the valve schedule or on the Drawings. Limit switches shall be NEMA Type 4, single pole, double throw type, camoperated, adjustable throughout travel range and rated at 10A for 120/240 V service.
 - f. Two limit switches which provide overlapping open and close dry contacts for remote monitoring shall be provided for each valve so designated.
3. Position Indicators (PI)
 - a. Visual valve position indicators shall be provided where indicated in the valve schedule and shall be model BM3-5 as manufactured by Westlock Controls Corp.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Piping and valve installation shall be as specified in Division 15 and as specified in other applicable sections of these specifications. Electric actuators, solenoid valves shall be installed per Division 16.

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- B. Plug valves shall be installed with the plug in the horizontal position, per the manufacturer requirements
- C. Install flushing connections on all check valves installed vertically on sludge lines

3.2 PLACEMENT OF VALVES

- A. Valves shall be installed at all service connections to and from equipment, branch lines from main lines, at low points for draining each system, at high points to vent air and as shown on the drawings.
- B. Plug valves shall be installed horizontally with the plug up when open, per the manufacture's recommendations.
- C. Chain wheel operators shall be provided for all valves located 6'-0" or more above floor surfaces. Chains shall be provided so that the chain loop reaches down to within three feet of the floor elevation that the valve will be operated from. Levers and handwheels shall be placed for ease of access. Check valves for sludge lines shall not be placed in a vertical position if placed vertically; install a flushing connection on cover plate.
- D. Pump suction isolation valves shall be placed a minimum of 5 diameters away from the pump suction flange.
- E. Install ball valves and vent/drain piping to vent air at the high points. Pipe shall be installed from the high point to the valve located at an accessible location. Continue piping to floor drain.

3.3 TESTS

- A. All diaphragm type pressure/surge relief vales, motor, pneumatic, hydraulic and solenoid actuated valves shall be calibrated and/or set up in the field by the manufacturer's field technician. When complete, a certificate of proper installation and As-Built Wiring diagram is required prior to acceptance tests.
- B. Field acceptance tests shall include operation of a full cycle under local and remote manual and remote automatic conditions, verification of proper position, panel lights, SCADA Screen indication (when required), and all alarm functions such as over-torque, failure to open/close, etc. (if applicable).
- C. All automatically operating valves shall be adjusted to the set points specified or those identified by the Engineer. Testing shall then be conducted to verify operation including any alarm functions.

3.4 MANUFACTURER'S FIELD SERVICE

- A. A factory representative employed by the manufacturer shall visit the site prior to equipment start-up to certify proper installation of the equipment, set open/close contacts and torque overloads, perform leakage tests, perform operator 40 lb. effort test and to instruct the Owner's operating personnel in the maintenance and operation of these units. The scheduling of this

service shall be coordinated with the Owner and the cost of this service shall be included in the Contractor's bid price for the equipment.

- B. Operation and maintenance training shall be provided for each type of actuator, unless otherwise specified.

3.5 VALVE TAGS

- A. Provide valve tags in accordance with Section 15000.

3.6 PAINTING

- A. The following schedule shall be used for painting items specified in the following Piping Sections and Valve Sections

Painting Item	System No.
Exterior, valves & operators	1
Interior, valves & operators (not specified elsewhere)	2
Submerged and non-submerged valves & operators in channels, tanks or wet well	6
Buried Valves	6

- B. For detailed painting requirements and system descriptions refer to Section 09900 of the Specifications.

END OF SECTION

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SECTION 15170

MOTORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. General requirements for electric motors furnished on equipment specified in other Sections, including single phase and three phase electric motors.

1.2 RELATED WORK

- A. Division 11 – Equipment
- B. Section 15100 – Valves and Actuators
- C. Section 15500 - Heating and Ventilation.
- D. Division 16 - Electrical.

1.3 REFERENCES

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
- D. ANSI/NEMA MG1 - Motors and Generators.
- E. ANSI/NFPA 70 - National Electrical Code.
- F. UL 674 - UL Standard for Safety Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 01300.
- B. Submit test results verifying nominal efficiency, inrush current, and power factor for three phase, high efficiency, or energy efficient motors.
- C. Submit manufacturer's installation instructions under provisions of 01300.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 01700.

- B. Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.6 REGULATORY REQUIREMENTS

- A. Conform to applicable electrical codes and ANSI/NFPA 70.
- B. Conform to UL Component Recognition for appropriate sizes.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 01600.
- B. Store and protect products under provisions of Section 01600.
- C. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.8 WARRANTY

- A. Provide one year manufacturer's warranty under provisions of Section 01700.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. General Electric.
- B. ABB Baldor Reliance.
- C. U.S. Motors.

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Motors: Design for continuous operation in 40 degrees C ambient, and for temperature rise in accordance with ANSI/NEMA MG1 limits for insulation class, Service Factor, and motor enclosure type. Motor speed shall not exceed 1800 RPM, unless specified otherwise.
- B. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over-temperature protection.
- C. Each electric motor shall be designed, constructed, and tested in conformity with all requirements of the applicable standards of the IEEE, NEMA, and ANSI, except as modified herein.
- D. The electric motors, unless otherwise specified, shall be of the totally enclosed, fan cooled, squirrel cage induction type, designed for continuous operation. Each motor shall have sufficient horsepower rating so that the motor current at rated voltage shall not exceed the nameplate rating under any condition of operation of the respective equipment.

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- E. The motors shall be rated for continuous duty operation using Class F insulation suitable for operation in an ambient temperature of 40 degrees C.
- F. The motor speed shall not exceed 1800 rpm, unless otherwise specified.
- G. The motors shall be equipped with grease lubricated ball bearings and grease fitting(s), with the lubrication type and schedule clearly identified in the submittals.
- H. NEMA Premium Efficiency type except for submersible motors.
- I. The motor terminal leads shall be brought outside the motor frame to an approved terminal box mounted on the side of the motor and the leads shall be equipped with terminal lugs. Oversize terminal boxes shall be provided where specified or so indicated on the Drawings. The motor frame shall have drain plugs.
- J. Where called for in specific sections of these Specifications, special quiet motors shall be provided.
- K. For motors used for pumping applications, the pump brake horsepower (bhp) requirements shall not exceed the motor nameplate horsepower (hp) under the operating conditions as listed in the applicable equipment schedule.
- L. Inverter Duty. All motors indicated by the equipment schedule for variable-speed duty shall be designed for use on Variable Frequency Drives without external filters or cable length limitations with the following requirements:
 - 1. Listed meeting NEMA MG1 Part 31
 - 2. Inverter-grade, 1600 volt
 - 3. Service factor of 1.0 when operated from a VFD
 - 4. Normally closed thermostat on stator windings
- M. Shaft Grounding Ring
 - 1. Motor windings shall be able to withstand the voltage spikes per NEMA MG1 Part 31.4.4.2 and protect against overheating when the motor is operating at slow speeds.
 - 2. Shaft grounding rings shall be provided and installed by the motor manufacturer and shall be installed in accordance with the manufacturer's recommendations.
 - 3. Motors up to 100 hp shall be provided with on AEGIS shaft grounding ring installed either on the drive end or non-drive end.
 - 4. Motors over 100 hp shall be provided with AEGIS shaft grounding ring on the drive end of the motor and an insulated bearing on the non-drive end.
- N. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor code letters, ambient temperature rating, temperature rise or insulation class, NEMA design letter (integral horsepower motors), frame size, manufacturer's name and model number, service factor, power factor, and nominal efficiency. Nameplate shall be of stainless steel or other approved corrosion resistant material providing a permanent legible marking. Nominal full load efficiency shall be identified on nameplate in accordance with NEMA MG-1-12.54.2
- O. Electrical Connection: Conduit connection boxes, threaded for conduit, shall be provided with motor terminal leads brought outside the motor frame and equipped with terminal lugs. For

fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

- P. A connection plate shall be provided for dual voltage motors and fastened firmly to the frame near the terminal box indicating the proper grouping of external leads for the power supply. This plate shall be of stainless steel or other corrosion resistant material which will provide a permanent legible marking.
- Q. The nameplates and connection plates shall be attached to the motor frame by stainless steel rivets or screws.

2.3 SINGLE PHASE POWER - SPLIT PHASE MOTORS

- A. Motors less than 1/2 HP shall be 115-volt AC, single phase, 60 Hz, unless indicated otherwise.
- B. Starting Current: Up to seven times full load current.
- C. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, pre-lubricated sleeve, or ball bearings.
- D. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings, automatic reset overload protector.

2.4 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Motors 1/2 HP and larger shall be 460/230 or 460-volt, 3 phase, 60 Hz, unless otherwise indicated.
- B. Starting Torque: Between one (1) and one and one-half (1 1/2) times full load torque.
- C. Starting Current: Up to six (6) times full load current.
- D. Power Output, Locked Rotor Torque, Breakdown or Pullout Torque: NEMA Design B characteristics.
- E. Design, Construction, Testing, and Performance: Conform to ANSI/NEMA MG1 for Design B motors.
- F. Insulation System: NEMA Class B or better.
- G. Testing Procedure: In accordance with ANSI/IEEE 112, Test Method B. Load test motors to determine freedom from electrical or mechanical defects and compliance with performance data.
- H. Motor Frames: NEMA standard frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts. Motor frames shall have drain plugs.
- I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours.

Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

- J. Sound Power Levels: To ANSI/NEMA MG1.
- K. Motor Enclosure: Totally enclosed, fan cooled, unless otherwise specified.
- L. Service Factor: 1.15, unless otherwise indicated.
- M. Nominal Efficiency: Meet or exceed EPACT values at full load and rated voltage when tested in accordance with ANSI/IEEE 112. High efficiency or energy efficient motors shall be in accordance with NEMA Standard MG-1-12.55 and efficiencies shall equal or exceed the efficiency values listed in NEMA MG-1 Table 12-10.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Motors drawing less than 250 Watts and intended for intermittent service may be germane to equipment manufacturer and need not conform to these Specifications.
- B. Explosion proof motors shall be provided for areas indicated as hazardous.
- C. Motors shall be high efficiency or energy efficient type.

3.2 SHOP DRAWINGS

- A. Shop drawings for motor driven equipment MUST include the following motor information:

1. Horsepower	9. Service Factor
2. Voltage	10. Power Factor
3. Phase	11. Efficiency
4. Frequency	12. NEMA Design Code Letter
5. Speed	13. Manufacturer
6. Maximum Temperature Rise In Continuous Service	14. Full Load Amperes
7. Enclosure Type	15. NEC Code Letter
8. Frame	16. Insulation Class
	17. Shaft Grounding

3.3 INSTALLATION

- A. Section 01400 - Quality Control: Manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.

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SECTION 15400

COMMON RESULTS FOR PLUMBING

PART 1 – GENERAL

1.1 SUMMARY

- A. Related Documents:
 - 1. Drawings and general provisions of the Subcontract apply to this Section.
 - 2. Review these documents for coordination with additional requirements and information that apply to work under this Section.
- B. Section Includes:
 - 1. Furnish services, skilled and common labor, and apparatus and materials required for the complete installation as shown and within the intent of the drawings and/or these Specifications.
 - 2. Requirements of this Section apply to Division 15 Sections.
- C. Related Sections:
 - 1. Section 00 72 00 General Conditions
 - 2. Section 00 73 00 Supplementary Conditions
 - 3. Section 01 75 00 Checkout and Startup Procedures
 - 4. Section 26 05 00 Basic Electrical Requirements
 - 5. Section 01 73 23 Seismic Anchorage and Bracing
 - 6. Division 09 Sections on paints and coatings

1.2 REFERENCES

- A. General:
 - 1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
- B. Refer to Section 00 72 00 General Conditions for the list of applicable regulatory requirements.
 - 1. Comply with Section 01 73 23 Seismic Anchorage and Bracing.

1.3 DESCRIPTION

- A. These Division 15 specifications define the statutory, administrative, procedural, and technical requirements of the mechanical and controls modifications, replacements, and/or upgrades products and services to be provided on this Subcontract.
- B. Provide plumbing work as indicated on the Drawings and specified in Division 15 including:
 - 1. Prepare coordination drawings, shop drawings, submittals, as-built drawings, and operating and maintenance instructions.

2. Determine items and quantities required.
3. Provide complete, continuous, operational, and functioning systems.
4. Fully coordinate with work of other Sections, including field verification of elevations, dimensions, clearance, and access.
5. Repair of all damage done to premises as a result of this installation and removal of debris left by those engaged in this installation.
6. Rigging, hoisting, transportation, and associated work necessary for placement of equipment in the final location shown.
7. Disassembly and re-assembly of equipment furnished under this Section, should this be required in order to move equipment into final location shown on the Drawings.
8. Labor, materials, tools, appliances and equipment that are required to furnish and install the complete installation for this section of the work including that which is reasonably inferred.
9. Cooperation with other crafts in putting the installation in place at a time when space required is accessible.
10. Temporary scaffolding necessary for performance of the work in this Division.
11. Cutting and core drilling required for work of Division 15, including locating of rebar or coordination of locating rebar with the General Contractor.
12. Pipe sleeves for all holes in walls, floors, and ceilings, and cutting of floor slabs and slabs on grade.
13. Waterproofing where necessary for installation under this Division.
14. Cooperation with and assistance to the Facilities Monitoring and Control System Contractor as required to provide a complete and functional plumbing system.
15. Counterflashing of roof penetrations for work of Division 15.
16. Sizes, and locations for installation of any curbs and pads for work of Division 15.
17. Temporary and permanent stands and supports for equipment requiring them including vibration isolation.
18. Temporary protection of existing installation.
19. Stenciling and equipment identification.
20. Firestopping of penetrations of ducts, piping, and conduits through walls, floors, and ceiling assemblies.
21. Temporary utilities as required to install work on Division 15 including lighting, water, gas, electricity, etc.
22. Fees, permits, inspections, taxes, and approach from agencies that have jurisdiction over installation of Division 15.
23. Participation in and coordination with the Commissioning process.
24. Warranty.

1.4 SUBMITTALS

- A. Submit under provisions of Section 00 72 00 General Conditions and Section 00 73 00 – Supplementary Conditions.
- B. Product Data: Submit manufacturer's technical product specification sheets for each system component and device to be provided that includes data needed to prove compliance with this specification. Clearly indicate the exact model of each component to be provided.
- C. Shop Drawings: The Subcontractor shall submit for approval shop drawings prepared in accordance with Section 01 33 00 Submittal Procedures and as required by other Sections of these specifications.

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1. Shop drawings shall be drawn to a scale of 1/4 inch = 1 foot (1:25) or larger, and shall include complete dimensions, locations, elevations, and clearances for plumbing, piping, ductwork, equipment, and valve numbers.
 - a. Prepare in AutoCad 2017 format or as otherwise directed.
 - b. Identify equipment using designations shown on the Contract Documents or as directed by the Owner's Representative. Do not proceed with identifications without approval from the Owner's Representative.
 2. All shop drawings shall clearly call out in bold letters and cloud symbols deviations from the specifications and contract documents, no matter how minor.
- D. Coordination Drawings:
1. Obtain drawings from the structural, electrical, sprinkler, plumbing, sheet metal, concrete, steel, and dry wall trades.
 2. Hold regular coordination sessions with trades until coordination issues are re-solved.
 3. Prepare separate composite coordination drawings to a scale of 1/4 inch = 1 foot (1:25) or larger, showing work of Divisions to demonstrate coordination, clearance, access, etc. between ductwork, equipment, temperature controls, cable trays, conduits, light fixtures, piping, plumbing, structural elements, architectural elements, etc. These drawings are to be the basis for the detailed shop drawings and need not be submitted, but are to be available for review upon request.
 - a. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 - b. Each trade is to adjust their shop drawings based on the outcome of coordination sessions.
 4. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work.
 5. Indicate scheduling, sequencing, movement, and positioning of large equipment in-to the building during construction.
 6. Indicate the proposed locations, of piping, ductwork, equipment, and materials. Include the following:
 - a. Clearances for installing and maintaining insulation.
 - b. Clearances for servicing and maintaining equipment, including specific ceiling tile or ceiling access panel access and space for equipment disassembly required for periodic maintenance.
 - c. Equipment connections and support details.
 - d. Fire-rated wall and floor penetrations.
 - e. Sizes and location of required concrete pads and bases.
 - f. Valve stem movement.
 - g. Sizes and locations of new and existing equipment support curbs on roof.
 - h. Sizes and locations of new openings, either sleeved, cut, or core-drilled, in new concrete construction unless specifically shown on the Structural Drawings.
 7. Maintain one complete set of composite coordination drawings at the job site. Periodically update drawings based on actual field conditions.
 8. Submit final coordination drawings as part of record document requirements.

- E. Submit manufacturer's operation and maintenance manuals in compliance with Section 07 78 23 Operation and Maintenance Data. Include a list of spare parts that the manufacturer recommends the Owner purchase.
- F. Lateral Force Anchorage: Submit lateral force anchorage calculations and details of anchorage of components to building including backing design. Seismic forces shall be in accordance with Section 01 73 23 Seismic Anchorage and Bracing with value 1.5 used as the minimum CBC seismic importance factor, Ip. Calculations shall be sealed by a Structural Engineer registered in the State or Commonwealth in which the project is located.
- G. Record Documents: Upon completion of the work covered by this Contract, as directed, furnish as-built drawings as specified in Division 01. Include changes installed under this Contract which are not in accordance with the Contract Drawings. Note that these as-built drawings are to be based on the Contract Drawings. In addition, submit final copies of the Shop Drawings and Coordination Drawings.

1.5 QUALITY ASSURANCE

- A. Materials and Equipment: materials and equipment shall be new. Materials and equipment for which tests have been established by Underwriter's Laboratories, Inc. shall be approved by that body and shall bear its label of approval.
 - 1. The first named manufacturer and product is the basis of design. Other manufacturers and/or products are considered as substitutions.
- B. In lieu of listing by an approved testing laboratory, consideration will be given to certified test reports of an adequately equipped, recognized independent test laboratory competent to perform such testing indicating conformance to requirements of the applicable Underwriter's Laboratories, Inc. standards.
- C. Unless otherwise approved by the Project Manager, the materials to be furnished under this specification shall be the standard products of manufacturers regularly engaged in the production of such equipment equal to or superior to the material specified, and shall be the manufacturer's latest standard design that complies with the specification requirements.
- D. Approval of Materials:
 - 1. Section 00 72 00 General Conditions requirements for Materials and Equipment and Submittals.
 - 2. A complete list of materials and equipment proposed shall be submitted to the Project Manager for approval. The list shall include for each item: the manufacturer, the manufacturer's catalog number, type or class, the rating, capacity, size, etc.
 - 3. Before installation of the equipment, the Subcontractor shall submit for approval detailed construction drawings for each item of fabricated equipment required for installation. Drawings shall be to scale and fully dimensioned and shall provide sufficient detail to clearly indicate the arrangement of equipment and its components.
 - 4. Installation of approved substituted equipment is the Subcontractor's responsibility, and changes required to work included under other divisions for installations of approved substituted equipment must be made to the satisfaction of the Owner's Representative and without change in contract price. Approval by the Owner's Representative of substituted equipment and/or dimension drawings does not waive these requirements.

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1.6 START-UP TRAINING

- A. Prepare a formal training program for operating staff prior to the scheduled start-up date. The program will consist of the design, start-up, and operation of the mechanical, plumbing, fire protection, and building automation systems. Coordinate the training program with the production of the operation and maintenance manuals. Provide indexed binder and training materials to each participant.
- B. Provide 16 hours (unless specified otherwise) of on-site training in the operation and maintenance for installed system and major piece of equipment. Systems include boilers and heating hot water system, chillers and chilled water system, plumbing, fire protection, air supply and exhaust systems, air conditioning units, balancing, and Facilities Monitoring and Control System. Trainers shall be experienced, manufacturer-approved personnel.
 - 1. Schedule training for each system in advance with the Owner's Representative.
 - 2. Include travel, per diem and incidental costs for personnel under contract to the Subcontractor.
 - 3. Operations and Maintenance data to be available for training sessions.

1.7 RULES AND REGULATIONS

- A. See Division 01.
- B. Provide work and materials in full accordance with the latest rules of the organizations listed in Division 01 and in other Sections of Division 15, and with prevailing rules and regulations pertaining to adequate protection and/or guarding of moving parts, or other-wise hazardous locations.
- C. Whenever the Drawings and Specifications require something which will violate the regulations, the regulations shall govern. Review the Drawings and Specifications, and request from the Owner's Representative clarification or revision of portion of the work in violation of the rules or regulations prior to installing the work. Necessary installation alteration required for compliance shall be made at no additional cost to the Owner.
- D. Whenever the Drawings and Specifications require larger sizes, or higher standards than are required by the regulations, the Drawings and Specifications shall govern.
- E. Strictly conform to the requirements of the National Fire Protection Association, National Electrical Code, International Building Codes, OSHA, Fire Marshal, and insurance underwriters' requirements. expenses required shall be borne under this Contract.

1.8 PROTECTION OF EQUIPMENT

- A. Protect, handle, and store products under provisions of Division 01.
- B. Assume responsibility for damage to of the work or premises before substantial completion. Should new or existing equipment become damaged, restore it to its original condition and finish before final acceptance. Damage incurred to the property or to the work of other Divisions, caused by this Division, shall be replaced or repaired by, and at the expense of, the Subcontractor to the satisfaction of the Owner's Representative. Exposed materials shall be clean at the time of acceptance of the project.

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1.9 SCHEDULING AND SEQUENCING

- A. Cooperate with other trades in putting this installation in place at a time when space re-quired is accessible, and in such a manner that other work in this space may be installed as shown on the Drawings. Schedule work and cooperate with the others to avoid delays, interferences, and unnecessary work, conforming to the construction schedule, making the installation when and where directed.
- B. Include labor and materials to install certain items furnished under this contract when required by the schedule. These items are part of this contract but may need to be installed only after completion of work under another contract which this contractor may or may not be participating in. It is the responsibility of this contract to coordinate with others to ensure that preparations are made and ready to accept the installation of these items. These items include, but are not limited to:
 - 1. Air inlets and outlet
 - 2. Temperature sensors.
 - 3. Monitoring and control panels.
 - 4. Sprinkler heads.
- C. If a discrepancy is discovered between engineering and architectural Drawings, whether with respect to a significant variance between location, variation in quantity, or violation of code requirements, notify Architect for clarification and do not proceed with the work affected until clarification has been made.
- D. Schedule work in advance with the Owner's Representative. No system shall be shut-down unless approved in writing.

1.10 TEMPORARY USE

- A. Should it become necessary to use the new portion of the system and the new equipment to warm or air condition part of the building before the completion of this work, the Owner reserves the right to make use of same at its own risk and expense, but the temporary use of the equipment shall not constitute an acceptance of the plant or part there-of in way. The Owner will bear the cost of fuel and electrical current for such temporary use of the equipment. If temporary use of new systems or equipment is solely for the benefit of the contractor, contractor shall bear the cost of fuel and electrical current for such temporary use.

1.11 WARRANTY

- A. Comply with Section 00 72 00 – General Conditions.
- B. Provide extended warranties where specifically required in subsequent sections of Division 15.

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PART 2 – PRODUCTS

2.1 GENERAL

- A. In addition to material and equipment specified, provide incidental materials to effect a complete installation. Such incidental materials include solders, tapes, caulking, mastics, gaskets and similar items.
- B. Materials and equipment shall be uniform throughout the installation. Equipment of the same type shall be of the same manufacturer. materials and equipment shall be new.

2.2 MATERIALS AND SUBSTITUTIONS

- A. Comply with Section 00 72 00 – General Conditions.

PART 3 – EXECUTION

3.1 EXAMINATION OF SITE

- A. Examine the site and become familiar with conditions that may affect the work covered by this Division of the Specifications.
- B. Arrange to meet with the Owner’s Representative at the job site before the work is started and discuss with them the various phases of the work and the procedure and preparation for testing and adjusting the systems.
- C. The general arrangement and location of piping ductwork, apparatus, etc., is shown on the Drawings or herein specified. Minor changes may be necessary to accommodate other work, new or existing, that may conflict with this work. Install this work in harmony with these trades and fully coordinate work.
- D. Visit the site of the work, take measurements, examine areas where work is to be performed and get such other information necessary for proper execution of the work. Ascertain and check conditions with the Drawings and Specifications, other trades, existing conditions and by what means the work is to be performed. No allowance shall subsequently be made for extra expense due to failure or neglect to make such examination and correlation. Where revisions or changes in the existing work are required to permit the installation of new work, they shall be made at no additional cost to the Owner. No allowance shall be subsequently made for error or omission.

3.2 ACCURACY OF DATA

- A. The Drawings indicate the general arrangement and location of piping, ducts, and equipment. Should it be necessary to deviate from arrangement or location indicated in order to meet architectural conditions or site conditions, or due to interference with other work, make such deviations as offsets, rises and drops in piping and ducts that may be necessary, whether shown or not, without extra expense to the Owner. Extreme accuracy of the data given herein and on the Drawings is not guaranteed. The Drawings and Specifications are for the assistance

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and guidance of this Section and exact locations, distances, and elevations shall be governed by actual site conditions.

3.3 COORDINATION ITEMS

- A. Coordinate mechanical work with that of other trades in order to:
 - 1. Avoid interferences between general construction, mechanical, electrical, structural and other specialty trades.
 - 2. Maintain clearances and advise other trades of clearance requirements for operation, repair, removal and testing of mechanical equipment.
 - 3. Indicate aisleways and accessways required on coordinated shop drawings for roof equipment area, mechanical equipment rooms, data and telecomm rooms, corridors, ceiling spaces, shafts, corridors, ceiling space, laboratories, etc.

- B. Understanding of Work:
 - 1. Study, examine, and compare of the contract documents, including drawings and specifications. The Subcontractor shall have a full understanding of how the work in this part is scheduled, phased, and installed with work of other trades.
 - 2. Include in this installation piping, ductwork, devices, and equipment that are necessary for complete and operating systems as specified and as required.
 - 3. Connect piping and ductwork from fixtures, outlets, and devices full size to the nearest suitable main or riser.
 - 4. Certain installations may be presented as typical, and full details are not repeated for each case. Subcontractor shall provide complete installation as if full details apply to each and every case and make adjustments to typical details to suit each specific installation as part of the basic work.
 - 5. Installation of work presented on the diagrams are applicable to the plans, and work depicted on the plans are applicable to the diagrams.
 - 6. If there is a discrepancy in the drawings or specifications, the contractor shall figure the work based on the most stringent requirements to complete the installation and obtain clarification from the Architect before installation.

- C. Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:
 - 1. Coordinate mechanical systems, equipment, and materials installation with other building components.
 - 2. Verify dimensions by field measurements.
 - 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
 - 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - 5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 - 6. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible. Work shall be above ceilings or ceiling line.
 - 7. Coordinate installation and connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of

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governing regulations, franchised service companies, and controlling agencies.
Provide re-required connection for each service.

8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Coordinate with individual system requirements.
9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
10. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as is practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
12. Coordinate with the locations of electrical panels and avoid installing piping and ductwork over them. Electrical panels are purposely located and have priority for location. The contractor is responsible for required piping and ductwork offsets to ensure that the panels are located as designed and for other conditions.
13. Perform system modification recommended by Test and Balance Agency after recommendations are accepted by the Owner's Representative.

3.4 WORKMANSHIP AND SUPERVISION

- A. Comply with of the following:
- B. General Requirements: Section 00 72 00 – General Conditions
- C. Special Requirements: Section 00 73 00 – Supplementary Conditions, in addition to the following.
 1. Measurements: Materials installed shall be to exact field measurements.
 2. The installation depicted on the Drawings is designed to fit tightly into work under other Sections or Divisions. It is the essence of this Contract that work be completely coordinated with other Sections or Divisions, and that locations of pipes and ducts be exactly determined in the field and cleared with other Sections or Divisions before the installation of these items is begun. No extra compensation will be made for failure to observe this clause.
 3. Adequate clearance for access to operable devices and automatic devices and for access to lubrication points shall be maintained in portions of the work including ductwork and piping installed on the roof. Tripping hazards shall be avoided.
 4. Provide architectural access doors where shown and where required for access to equipment and operable devices.
 5. Gauges, thermometers, and other indicating devices shall be installed so that they can be easily read from the floor.

3.5 MATERIAL DELIVERY AND STORAGE

- A. Comply with Section 01 65 00 Product Delivery Requirements.
- B. Comply with Section 01 66 00 Product Storage and Protection Requirements.

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3.6 INSTALLATION

- A. Manufacturer's Directions: Follow manufacturer's directions covering points not shown on the drawings or specified herein. Manufacturer's directions do not take precedence over drawings and Specifications. Where these are in conflict with the drawings and Specifications, notify the Project Manager for clarification before installing the work.
- B. Carpentry, Cutting, Patching, and Core Drilling:
 - 1. Provide carpentry, cutting, patching, and core drilling required for installation of material and equipment specified in this Division.
 - 2. No penetrations shall be sleeved, cut, or core drilled through concrete construction without a submittal indicating exact locations and sizes and specific written approval from the Owner's Representative or unless specifically shown on the Structural Drawings.
 - 3. It is the Subcontractor's responsibility to accurately size and locate openings through the structure. The dimensions shown on the Structural Drawings are for general information only. Provide specific sizes, dimensions, requirements, etc.
- C. Seismic Mounting:
 - 1. Material and equipment, including floor mounted equipment, piping, and appurtenances shall comply with Section 01 73 23 – Seismic Anchorage and Bracing.
- D. Waterproof Construction:
 - 1. Maintain waterproof integrity of penetrations of materials intended to be waterproof. Provide flashings at exterior roof penetrations. Caulk penetrations of foundation walls and floors watertight. Provide membrane clamps at penetrations of waterproof membranes.
 - 2. Provide waterproof NEMA 3R enclosures for equipment or devices mounted outside or otherwise exposed to the weather.
- E. Sleeves, Stubs, and Slab Penetrations: Section 15401 – Hangers and Supports for Plumbing Piping and Equipment.
- F. Painting of Mechanical Equipment and Hardware:
 - 1. Comply with applicable Division 09 sections for paints and coatings.
 - 2. Provide moisture resistant paint for exterior painting.
 - 3. Colors shall be as shown on the drawings unless specified.
 - 4. Comply with individual Sections for other equipment to be painted.
 - 5. Repair damaged galvanizing, paint, or coatings. Use Z.R.C. (no known equal) cold galvanized compound for galvanized repairs.
- G. Concrete Equipment Bases:
 - 1. All equipment located on concrete floor inside the building or on grade outside the building, shall be mounted on a concrete base. The concrete base shall be four inches high and shall extend six inches beyond the edge of equipment base unless indicated otherwise on drawings.
 - 2. Coordinate concrete bases: Concrete bases indicated on Architectural or Structural drawings are specified in other Divisions. Concrete bases not on Architectural or Structural drawings are requirements of this Division.

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3.7 PIPING AND EQUIPMENT IDENTIFICATION

- A. Comply with Section 15402 Identification for Plumbing Piping and Equipment.

3.8 NOISE AND VIBRATION

- A. The target room NC sound levels for the operating HVAC system is as follows:

Rooms with Fume Hoods	55 (not including fume hood components)
Labs with Benches	45
Lab Support Rooms	45
Clean Rooms	55
Conference Rooms	36
Corridors/Utility Areas	45

- B. If noise or vibration problems are a result of improper material or installation, or exceeds limits by above Paragraphs - 3.03.A and 3.03.B, these conditions shall be corrected by the Subcontractor at no cost to the Owner.

3.9 SHUTDOWN AND SCHEDULING

- A. Comply with Section 00 73 00 Supplementary Conditions.

3.10 PROTECTION OF EQUIPMENT

- A. Care shall be exercised during construction to avoid damage or disfigurement. Equipment shall be protected from dust and moisture prior to and during construction. The Subcontractor is cautioned that concrete finishing, painting, etc. in electrical rooms shall not proceed if unprotected equipment is installed.
- B. Where required or directed, construct temporary protection for equipment and installations for protection from dust and debris caused by construction.
- C. All protection shall be substantially constructed with the use of clean canvas, heavy plastic, visqueen and plywood as required, and made tight and dust proof as directed.
- D. The Subcontractor shall repair by spray or brush painting, after properly preparing the surface, scratches or defects in the finish of the equipment. Only identical paint furnished by the equipment manufacturer shall be used for such purposes.
- E. Failure of the Subcontractor to protect the equipment as outlined herein shall be grounds for rejection of the equipment and its installation.

3.11 INSPECTIONS

- A. Comply with Section 00 73 00 Supplementary Conditions.

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3.12 REMOVED EQUIPMENT AND MATERIALS

- A. Comply with Section 00 73 00 Supplementary Conditions.

3.13 CLEANING

- A. Comply with Section 00 73 00 Supplementary Conditions.

3.14 LUBRICATION

- A. All lubrication points shall be accessible. Where this is impossible, provision shall be made for lubrication at an accessible location. Where oil is used, an oil level indicator and capped, vented filling connection shall be provided and firmly mounted in an accessible space and shall be connected to the bearing with pipe(s) as required. Where grease is used for lubricant, the pipe shall have a suitable lubricating fitting installed at the accessible end. Equipment shall be thoroughly lubricated before operation and at time work is accepted.

3.15 SEALANTS

- A. See Division 07 Sections for sealing duct, pipe, and conduit penetrations through walls, partitions, and floors.
- B. Completely seal duct, pipe and conduit penetrations through rated and non-rated walls.

3.16 TESTS

- A. Upon completion of the mechanical construction work, perform tests and provide test reports as specified in this and other Sections.
 - 1. All tests shall be made in the presence of a representative of the Project Manager. The application or interruption of mechanical utilities shall be programmed and directed by the Project Manager.
 - 2. The Subcontractor shall submit to the Project Manager 3 copies of test results, certified in writing, witnessed, signed and dated, immediately upon completion of work. Unsatisfactory condition revealed by these test results, or unsatisfactory methods of tests and/or testing apparatus and instruments, shall be corrected by the Sub-contractor to the satisfaction of the Project Manager.
 - 3. The Project Manager reserves the right to require that the Subcontractor perform and repeat tests that are deemed necessary to complete or check the tests or the certified records of the Subcontractor during the course of the work. Correct unsatisfactory portion of its work that is revealed by the tests or that may be due to progressive deterioration during this period, unless the item in question was a direct specification.

3.17 COMMISSIONING

- A. Perform commissioning requirements of:
 - 1. Section 01 75 00 – Checkout and Startup Procedures
 - 2. Section 21 08 00 – Commissioning of Fire Suppression
 - 3. Section 22 08 00 Commissioning of Plumbing
 - 4. Section 23 08 00 Commissioning of HVAC Systems
 - 5. Section 26 05 00 Basic Electrical Requirements

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- B. Commissioning is included as a part of the total package of quality assurance and quality control for this project. Commissioning is to be integrated into the project as the process that oversees and verifies the functional performance of equipment, systems, and assemblies via observation and testing. Include coordination with and full participation in the commissioning process. Commissioning shall include but not be limited to field observations, factory and site tests, pre-start checks, start-up checks, functional test procedure review, functional testing, commissioning meetings, documentation, test interpretation, and deficiency correction. The details of these requirements are described in the above Sections and other referenced Sections and are hereby incorporated by reference into the work of this Division.

3.18 MAINTENANCE AND OPERATING INSTRUCTIONS AND TRAINING

- A. Refer to Section 00 72 00 □ General Conditions for maintenance and operating instructions, and training requirements.
- B. At time of occupancy, arrange for manufacturer's representatives to instruct operating and maintenance personnel in the use of equipment requiring operating and maintenance. Arrange for personnel to be instructed at one time. Costs for this service shall be included in the Subcontract.
- C. Maintenance and operating instructions and training for Owner-furnished equipment will be provided by the equipment vendor. The Subcontractor shall be responsible for other equipment.

-END OF SECTION-

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SECTION 15401

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 -- GENERAL

1.1 SUMMARY

- A. Related Documents:
 - 1. Drawings and general provisions of the Subcontract apply to this Section.
 - 2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

- B. Section Includes:
 - 1. Pipe, duct, and equipment hangers and supports.
 - 2. Anchors, equipment bases and supports.
 - 3. Sleeves and seals.
 - 4. Flashing, counter flashing and pipe stacks.
 - 5. Firestopping.

- C. Related Sections:
 - 1. Section 01000 – General Specifications.
 - 2. Section 05051 – Anchors for seismic bracing of ductwork and piping.
 - 3. Division 03 Section – Concrete.
 - 4. Section 07900 – Joint Fillers, Sealants and Caulking.
 - 5. Section 15403 – Plumbing Piping Insulation.
 - 6. Section 15404 – Facility Water Distribution Piping.

1.2 REFERENCES

- A. General:
 - 1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
 - 2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
 - 3. Refer to ITB – Bid Documents for the list of applicable regulatory requirements.
 - 4. Refer to Section 15400 – Common Results for Plumbing for codes and standards and other general requirements.

- B. Code of Federal Regulations 29 CFR 1910.7:
 - 1. Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL).

- C. National Fire Protection Association (NFPA)
 - 1. NFPA-13 Installation of Sprinkler Systems
 - 2. NFPA-14 Installation of Standpipe and Hose Systems

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- D. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA):
 - 1. Seismic Restraint Manual: Guidelines for Mechanical Systems - latest edition for the support of ductwork.
- E. Section 5051 – Anchors for seismic bracing of ductwork and piping.
- F. UL Fire Resistance Directory, latest edition.

1.3 SUBMITTALS

- A. Submit under provisions of Section 15400– Common Results for Plumbing - Review of Materials and Section 01300 - Submittals.
- B. Submit calculations showing compliance with Section 5051 – Anchors, for piece of equipment whether supported or braced from above or below.
- C. Submit calculations showing compliance with Section 5051 – Anchors for seismic bracing of ductwork and piping.
- D. Submit shop drawing of hanger and support spacing, framing and attachment methods.
- E. Submit firestopping systems for every application.

1.4 QUALITY ASSURANCE

- A. Comply with the following:
 - 1. Supports for Sprinkler Piping: NFPA 13.
 - 2. Supports for Standpipes: NFPA 14.
- B. Do not use black steel devices, components, fasteners, etc. within the Clean Room interstitial space or in related air flow path. Steel items shall be plated, galvanized, painted, or coated.

PART 2 -- PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- A. Hangers for Pipe Sizes ½ (12.7 mm) to 1-1/2 Inch (38 mm): Carbon steel, adjustable swivel ring, UL listed, Grinnell Fig. 69 or equal. Use plastic coated hangers at all uninsulated copper piping.
- B. Hangers for Pipe Sizes 2 Inches (50.8 mm) and Cold Pipe Sizes 6 Inches (152.4 mm) and Over: Carbon steel, black or galvanized, adjustable, clevis, UL listed, Grinnell Fig. 260 or equal.
- C. Hangers for Hot Pipe Sizes 6 Inches (152.4 mm) and Over: Adjustable steel yoke, cast iron roll, double hanger.

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- D. Trapeze Supports: 12 gauge channel complete with nuts, pipe clamps, pipe straps, and drive-in end caps. Furnish cushion strip on all uninsulated copper piping and; cast iron roll and stand for hot pipe sizes 6 inches and over.
- E. Pipe Supported Tight to Wall, Floor, or Ceiling: Superstrut A1200, Unistrut P1000, or equal, 12 gauge channel complete with pipe clamps, nuts, bolts, and end caps. Furnish cushion strip on all uninsulated copper piping. and adjustable steel yoke and cast iron roll for hot-pipe sizes 6 inches and over.
- F. Vertical Support: Steel riser clamp, UL listed, Grinnell Fig. 261, Superstrut C720, or equal.
- G. Floor Support for Pipe Sizes to 4 Inches (101.6 mm) and Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.
- H. Floor Support for Hot Pipe Sizes 6 Inches (152.4 mm) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- I. Shield for Insulated Piping 2 Inches and Smaller: 18-gauge (1.31 mm) galvanized steel shield over insulation in 180 degree segments, at least 12 inches (300 mm) long at pipe support.
- J. Pipe Shields: Pipe Shields Inc., FRI, or equal, pipe hanger shield with waterproofed calcium silicate insulation encased in a galvanized metal casing completely around the pipe. Provide insulation same thickness as pipe insulation. Furnish the following models:
 - 1. Chilled Water: A2000 with calcium silicate insulation extending 1 inch (25 mm) beyond the metal casing.
 - 2. All others: A1000.
- K. Concrete Anchors: In accordance with Section 03300 – Concrete.

2.2 Duct Supports

- A. See Division 15.

2.3 HANGER RODS

- A. Steel, threaded both ends, threaded one end, or continuously threaded.

2.4 ATTACHMENTS TO STRUCTURE

- A. Inserts for new formed concrete construction: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods. For Suspension from New Formed Concrete Structure: Grinnell Figure 282, Superstrut 452, or equal, UL listed for the rod sizes, Grinnell, Fig. 282, Superstrut 452, or equal.
- B. Connection to Existing Concrete Structure: Hilti Kwik-Bolt, Phillips or equal, wedge type expansion anchors. Powder-driven fasteners may be used only for flexible duct, metal duct up to 16 inches (400 mm) round (or rectangular equivalent), and for air inlet and outlet wire seismic braces, and only within the parameters of the fastener's ICBO report. Provide current ICBO report. Do not use powder-driven fasteners for pipes or conduits.

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- C. For Suspension from New Formed Concrete Structure: B-Line B3014, Grinnell Figure 282, Superstrut 452, or equal, adjustable concrete insert.
- D. For Support on New Concrete: Galvanized steel headed bolts.
- E. Welded Connection to Steel Beams: B-Line B3083, Grinnell, Superstrut, or equal, steel welded beam attachment.
- F. Clamp Connection to Steel Beams: B-Line, Grinnell, Superstrut, or equal, beam clamp with retaining clip style as required by load.

2.5 SUPPORTS, BRACING, AND ACCESSORIES

- A. Miscellaneous Steel: Angles, channels, brackets, rods, clamps, etc., of new materials conforming to ASTM A36. Hot-dip galvanize steel parts after fabrication where used outdoors or inside the penthouse.
- B. Fasteners: Bolts and nuts, except as otherwise specified, shall conform to ASTM Standard Specifications for Low Carbon Steel Externally and Internally Threaded Standard Fasteners, Designation A307. Bolts shall have heavy hexagon heads, and nuts shall be of the hexagon heavy series. Bolts, washers, nuts, anchor bolts, screws and other hardware used outdoors or inside the penthouse shall be galvanized, and galvanized nuts shall have a free running fit. Provide bolts of ample size and strength for the purpose intended. Ferrous metal components below grade shall be stainless steel.
- C. Sheet Metal Screws: Plated, size 10 minimum.
- D. Pre-engineered duct and pipe bracing systems may be Mason Industries Seismic Sway Brace System or equal.

2.6 COUNTER FLASHING

- A. Metal Flashing: 26-gauge galvanized steel.
- B. Flexible Flashing: 47-mil thick sheet butyl; compatible with roofing.
- C. Caps: Steel, 16 gauge.

2.7 EQUIPMENT CURBS

- A. See Architectural and Structural Drawings for the design detail of the equipment curb.

2.8 SLEEVES

- A. Adjust-To-Crete, AMI Products, or equal, 24 gauge, electro-galvanized adjustable sleeve, up to 6" diameter. For 8 inches (200 mm) and larger, provide galvanized standard weight steel pipe sleeves
- B. Sleeves for Round Ductwork: Form with galvanized steel.

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- C. Sleeves for Rectangular Ductwork: Form with galvanized steel or wood.
- D. Caulk: Acrylic sealant of quality specified in Section 07900 – Joint Fillers, Sealants and Caulking.

2.9 FIREPROOFING OF FLOOR AND WALL PENETRATIONS

- A. Materials and installation shall comply with U.L. Fire Resistance Directory, for Through-Penetration for Firestop Devices, latest edition.

2.10 FABRICATION

- A. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- B. Design hangers for installation without disengagement of supported pipe.

2.11 FINISH

- A. Prime-paint exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- B. Steel in the Clean Room interstitial space is considered exposed.
- C. Hot-dip galvanized outdoors.
 - 1. Repair damage to galvanizing at welds, scratches, etc. using Z.R.C. (no known equal) cold galvanizing compound.

PART 3 -- EXECUTION

3.1 Attachments to structure

- A. Concrete Structure: Locate anchors from Edge condition and at a spacing to obtain maximum working loads specified in the applicable ICC report.
- B. See structural drawings for additional restrictions for locating anchors.
- C. Steel Structure: Attach at beam axis. Avoid eccentric loads wherever possible.
- D. Rating: Ultimate strength at least five times the imposed load.
- E. Submit for structural review pipe hanger locations, point loads and structural attachment details for pipes 6" and larger.
- F. Coordinate installation so that attachments to structure are made prior to fireproofing. If attachments must be made after fireproofing, then thoroughly clean area of fire proofing before welded or bolted attachments are made and replace fireproofing as necessary. Fireproofing material shall match existing.

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- G. Where point loads, imposed by work of Division 15, are greater than can safely be carried by the roof or deck, provide structural steel spreader beams tied to the building structure. Submit details of such spreader beams for approval.
- H. Inserts:
 - 1. Furnish inserts to Division 03 Sections – Concrete and Concrete Forming for placement in concrete form work.
 - 2. Furnish inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Furnish hooked rod to Division 03 Sections – Concrete and Concrete Forming for inserts carrying pipe larger than 4 inches (100 mm).
 - 4. Where concrete slabs form finished ceiling, furnish inserts to be flush with slab surface.
 - 5. Where inserts are omitted, submit an attachment plan to the Owner’s Representative.

3.2 Supports, Bracing, and Accessories

- A. Common support systems: This Section is responsible for the provision, coordination, calculations, and seismic bracing of support systems common to Division 15 work. Individual section shall provide their own horizontal support struts. Division 15 shall coordinate with other divisions of all aspects of hanger installation, horizontal strut installation, pipe/conduit/cable tray/etc. installation, seismic bracing installation, and so on.
- B. Set machines and devices dead level, except where pitch or slope is specified or shown. Securely fasten to the structure unless shown otherwise. Use dry pack cement grout to obtain complete contact between structure and equipment.
- C. This Section is responsible for the concrete work for the support of equipment provided by this Section. Coordinate locations with anchor bolts before concrete is placed.
- D. Pipe Hangers and Supports:
 - 1. Support horizontal piping as follows:

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PART 4 Pipe Size	PART 5 Maximum Hanger Spacing	PART 6 Hanger Diameter
PART 7 1/2 to 1-1/4 inch (12.7 to 31.75 mm)	PART 8 6 feet 6 inches (2 m)	PART 9 3/8 inch (9.5 mm)
PART 10 1-1/2 to 2-inch (38.1 to 50.8 mm)	PART 11 10 feet (3 m)	PART 12 3/8 inch (9.5 mm)
PART 13 2-1/2 to 3-inch (63.5 to 76.2 mm)	PART 14 10 feet (3 m)	PART 15 1/2 inch (12.7 mm)
PART 16 4 to 6-inch (101.6 to 152.4 mm)	PART 17 10 feet (3 m)	PART 18 5/8 inch (15.9 mm)
PART 19 8 to 12-inch (203.2 to 304.8 mm)	PART 20 14 feet (4.25 m)	PART 21 7/8 inch (22.2 mm)
PART 22 14 inch (355.6 mm) and over	PART 23 20 feet (6 m)	PART 24 1 inch (25 mm)
PART 25 PVC (All sizes)	PART 26 6 feet (1.8 m)	PART 27 3/8 inch (9.5 mm)
PART 28 C.I. Bell and Spigot (or No-Hub)	PART 29 5 feet (1.5 m) at joints	PART 30 3/8 inch (9.5 mm)

1. Install hangers to provide at least 1/2 inch (13 mm) space between finished covering and adjacent work.
2. Place a hanger within 12 inches (300 mm) of each horizontal elbow.
3. Use hangers with at least 1-1/2 inch (38 mm) vertical adjustment.
4. Support horizontal cast iron pipe adjacent to each hub, with 5 feet (1.5 m) maximum spacing between hangers.
5. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers. Use specified pipe shields (if applicable). Trapeze size, and support size and spacing shall be governed by the cumulative weight of the supported piping. Maximum trapeze deflection shall be 1/240th of the span on a maximum stress of 15,000 psi (103.5 MPa), whichever is more stringent.
7. Support riser piping independently of connected horizontal piping.
8. Brace piping longitudinally and transversely as specified and indicated on the drawings.
9. Support pipe from the building structure so that there is no apparent deflection in pipe runs. Fit piping with steel sway braces and anchors to prevent vibration and/or horizontal displacement under load when required. Do not support from, or brace to, ducts, other pipes, conduit, or materials except building structure. Piping or equipment shall be immobile and shall not be supported or hung by wire, rope, plumber's tape, plastic ties, or blocking of any kind. Vertical piping running between floors shall be additionally supported at mid points in a rigid and immobile fashion. Exposed or concealed piping which can be physically moved, and which is not properly supported will not be accepted, and additional support or bracing will be required. Install seismic bracing as at locations as specified in the contract drawings.

10. Install and secure equipment with anchors and braces to floors, structural members and walls with sufficient backing, to prevent vibration and/or horizontal displacement under load and seismic force as hereinbefore specified. Follow manufacturer's recommendations for the installation of vibration isolators where required for equipment requiring such.

B. Equipment Bases and Supports:

1. Comply with Division 03 Sections – Concrete and Concrete Forming for concrete bases.
2. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
3. Construct support of steel members. Brace and fasten with flanges bolted to structure. Level equipment installed on steel rails using shims to compensate for the deflection of the steel.
4. Provide rigid anchors for pipes after vibration-isolation components are installed.

C. Counter Flashing:

1. See Architectural Drawings for flashings.
2. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weatherproofed or waterproofed walls, floors, and roofs.
3. Counterflash vent and soil pipes projecting at least 3 inches (75 mm) above finished roof surface with lead worked at least 1 inch (25 mm) into hub, at least 8 inches (200 mm) clear on sides using 24 inches (600 mm) by 24 inches (600 mm) sheets. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.
4. Counterflash floor drains in floors with topping over finished areas with lead, 10 inches (250 mm) clear on sides using at least 36 inches by (900 mm) 36 inches (900 mm) sheets. Fasten flashing to drain clamp device.
5. Seal floor, shower, mop sink, and drains watertight to adjacent materials.
6. Provide acoustical-lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.
7. Provide curbs for mechanical roof installations at least 14 inches (350 mm) high above roofing surface. Counterflash with flexible sheet and counterflash with sheet metal; seal watertight.

D. Sleeves:

1. Set sleeves in position in formwork. Provide reinforcing around sleeves.
2. Extend sleeves through floors 1 inch (25 mm) above finished floor level. Caulk sleeves full depth and provide floor plate.
3. Where piping or ductwork penetrates floor, ceiling, or wall, close-off space between pipe or duct and adjacent work with fire-stopping insulation and caulk airtight. Provide close-fitting metal collar or escutcheon covers at both sides of penetration.
4. Install chrome-plated steel escutcheons at finished surfaces.

30.2 SEISMIC RESTRAINTS

- A. Provide support hangar system, equipment, ductwork and piping with seismic restraints in accordance with specifications.

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- B. Pipe seismic restraints shall not interfere with pipe thermal expansion loop action or pipe building joint expansion loop action.

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SECTION 15402

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 -- GENERAL

1.1 SUMMARY

A. Related Documents:

1. Drawings and general provisions of the Subcontract apply to this Section.
2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

B. Section Includes:

1. Identify all installed mechanical distribution piping, mechanical equipment and components.
2. Cast-in-place concrete.

C. Related Sections:

1. Section 00 72 00 - General Conditions
2. Section 00 73 00 - Supplementary Conditions
3. Section 09 90 00 - Painting for identification painting

1.2 REFERENCES

A. General:

1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
3. Refer to Section 00 72 00 □ General Conditions for the list of applicable regulatory requirements.
4. Refer to Section 15400 □ Common Results for Plumbing for codes and standards, and other general requirements.

B. ASME –American Society of Mechanical Engineers:

1. ASME A 13.1 - Scheme for the identification of piping systems

1.3 SUBMITTALS

A. Submit under provisions of Section 15400 - Common Results for Plumbing, Review of Materials and Section 00 72 00 - General Conditions.

B. Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

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- D. Submit valve database as per Paragraph 3.05 - Stenciling and Identification, D.3 - Valve Tags.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. W. H. Brady or Westline products.
- B. No substitutions.

2.2 MATERIALS

- A. Color coding: ASME A13.1 unless specified otherwise.
- B. Plastic nameplates: laminated two-layer plastic with engraved black letters on light, contrasting background color.
- C. Plastic tags: laminated three-layer (double-sided) plastic with engraved black letters on light, contrasting background color. Tag size at least 1-1/2 inch (38 mm) diameter.
- D. Stencils: with clean-cut symbols and letters of following size:

Outside Diameter of Insulation or Pipe	Color Field Length	Letter Height
¾ to 1-1/4 inches (9.5 to 31.7 mm)	8 inches (200 mm)	½ inch (13 mm)
1-1/2 to 2 inches (38.1 to 50.8 mm)	8 inches (200 mm)	¾ inch (20 mm)
2-1/2 to 2 inches (63.5 to 50.8 mm)	12 inches (300 mm)	1 ¼ inch (32 mm)
8 to 10 inches (203.2 to 254 mm)	24 inches (600 mm)	2 ½ inch (64 mm)
Over 10 inches (254 mm)	32 inches (800 mm)	3 inches (75 mm)
Ductwork and equipment	---	2 ½ inch (64 mm)

- E. Stencil paint: semi-gloss enamel; in accordance with Section 09 90 00 □ Painting.
- F. Plastic pipe markers: factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and fluid being conveyed.
 - 1. Special gases shall be identified using markers with yellow background and black letters, direction arrow, and full chemical names and symbols.
- G. Plastic-tape pipe markers: flexible, vinyl-film tape with pressure-sensitive adhesive backing and printed markings.

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PART 3 -- EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive of identification materials.
- B. Prepare surfaces in accordance with Section 09 90 00 □ Painting for stencil painting.

3.2 INSTALLATION

- A. Plastic nameplates: install with corrosion-resistant mechanical fasteners, or adhesive.
- B. Plastic tags: install with corrosion-resistant chain.
- C. Stencil painting: apply in accordance with Section 09 90 00 □ Painting.
- D. Plastic pipe markers: install in accordance with manufacturer's instructions.
- E. Plastic-tape pipe markers: install completely around pipe in accordance with manufacturer's instructions.
- F. Underground plastic pipe markers: install 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.

3.3 IDENTIFICATION SCHEDULE

- A. Equipment: identify air-handling units, pumps, heat-transfer equipment, tanks, and water-treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with plastic tags.
- B. Controls: identify control panels and major control components outside of panels with plastic nameplates.
- C. Valves: identify valves in main and branch piping with tags.
- D. Piping: identify piping, concealed or exposed, with stenciled painting. Tags may be used on small diameter piping. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not more than 20 feet (6 m) apart on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
- E. Ductwork: identify ductwork with stenciled painting. Identify as to air-handling unit number, and area served. Locate identification at air-handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

3.4 VALVE DATABASE

- A. Provide specified valve database.

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3.5 STENCILING AND IDENTIFICATION

- A. Stencil each piece of new and existing equipment including pumps, fans, tanks, etc., with the equipment tags scheduled on the drawings. Use minimum 2 inches (50 mm) high characters.
 - 1. Stencil each duct leaving the mechanical room indicating fan unit, area(s), direction of flow, or room(s) served.
 - 2. Stencil each duct branch leaving an air shaft at each floor with fan number, and identify it as a supply, exhaust, or return duct, and indicate direction of air flow.
- B. Post a framed and typewritten schedule of all stencils, pipe markers, valve tags, and lubricants used, with identification, shall be framed and posted in the mechanical equipment room.
- C. Identify all pipes with specified markers.
 - 1. Install markers every 10 feet (3 m) on mains, at all branch take-offs and adjacent to valves and cocks.
 - 2. Apply to all exposed pipes, pipes behind removable tile ceiling, pipes in concealed but accessible locations, such as behind access panels and at least once in each room.
 - 3. Install pipe marker using pressure sensitive adhesive in accordance with the manufacturer's directions. The marker shall completely cover the circumference of the pipe and overlap itself.
- D. Valve Tags: Provide numbered tags for main valves, branch valves, zone valves, shut-off valves, and balancing valves installed under this Contract, constructed of #18 gauge (1.02 mm) brass, circular, 1 ¼ inches (31.7 mm) in diameter, and with numbers cut in and blackened so as to be plainly discernible. Fasten tags to valve with brass links.
 - 1. Valve numbers not required for valves obviously serving equipment such as air handler coils, reheat coil valves, and miscellaneous drains.
 - 2. On the as-built drawings, indicate the location and number of each tagged valve.
 - 3. Provide a computer file database in a form agreeable to the Owner, describing the valve, number, location, type of service normally "open" or "closed", specific duty of each tagged valve, and manufacturer and model number.
- E. Warning Sign at Fume Exhaust Plenums: Place warning sign on each fume exhaust plenum access - "WARNING. HAZARDOUS ATMOSPHERE INSIDE. USE BREATHING APPARATUS" when breaching containment.
- F. Place warning signs on all machines driven by electric motors which are controlled by fully automatic starters.
- G. Fire dampers and fire smoke dampers: at each fire damper or fire smoke damper access panel, label "FIRE DAMPER" or "FIRE SMOKE DAMPER" in minimum 2 inches (25 mm) high letters. Fire smoke dampers shall be provided with tags to identify each fire smoke dampers as "FSD-NUMBER SEQUENCES-BLDG NUMBER". Provide chart to the Owner's Representative for approval.
- H. Wherever charts, Shop Drawings, etc. refer to specific room numbers, use room numbers that will be provided by the Owner rather than the room numbers indicated on the Drawings.

-END OF SECTION-

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SECTION 15403

PLUMBING PIPING INSULATION

PART 1 -- GENERAL

1.1 SUMMARY

- A. Related Documents: Drawings and general provisions of the Subcontract apply to this Section.
 - 1. Review these documents for coordination with additional requirements and information that apply to work under this Section.
- B. Section Includes:
 - 1. Piping insulation.
 - 2. Jackets and accessories.
- C. Related Sections:
 - 1. Section 09900 – Painting for painting insulation jacket.
 - 2. Section 15402 – Identification for Plumbing Piping and Equipment.

1.2 REFERENCES

- A. General:
 - 1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
 - 2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
 - 3. Refer to Section 15400 – Common Results for Plumbing for codes and standards, and other general requirements.
- B. ASTM International:
 - 1. ASTM-B-209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
 - 2. ASTM-C-195 – Standard Specification for Mineral Fiber Thermal Insulating Cement
 - 3. ASTM C 196 – Standard Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement
 - 4. ASTM-C-449 – Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
 - 5. ASTM-C-533 – Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
 - 6. ASTM C534 / C534M – Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
 - 7. ASTM-C-547 – Standard Specification for Mineral Fiber Pipe Insulation
 - 8. ASTM-C-552 – Standard Specification for Cellular Glass Thermal Insulation
 - 9. ASTM C553 – Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications

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10. ASTM-C-578– Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
 11. ASTM-C-610 – Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation
 12. ASTM-E-84 – Standard Test Method for Surface Burning Characteristics of Building Material.
 13. ASTM C 450 – Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging
 14. ASTM C 921 – Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
 15. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
 16. ASTM A666 – Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
- C. Code of Federal Regulations 20-CFR-1910.7 Definitions and Requirements for A Nationally Recognized Testing Laboratory (NRTL)
- D. National Fire Protection Association NFPA-90A & NFPA-255 Surface Burning Characteristics of Building Materials
- E. Underwriters Laboratories UL-723 Surface Burning Characteristics of Building Materials

1.3 SUBMITTALS

- A. Submit under provisions of Section 15400 – Common Results for Plumbing and Review of Materials.
- B. Subcontractor shall submit the product description, list of materials and thickness for each service, and at each location.
- C. LEED Submittals:
 1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.

1.4 QUALITY ASSURANCE

- A. Subcontractor shall assure applicator is a company specializing in piping insulation application with at least 3 years of relevant experience.
- B. Fire Hazard: Provide insulation, jackets, facings adhesives and accessories acceptable to the State Fire Marshall and meeting the requirements of NFPA 90A. Meet the following hazard classifications stated in accordance with U.L. Test Method of Fire Hazard Classifications of Building Materials, No. 723:
 1. Flame-spread: Maximum 25.
 2. Fuel Contributed: Maximum 50.
 3. Smoke Developed: Maximum 50.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manville Corporation, Certain-Teed, or Owens Corning Fiberglass.
- B. Armacell (Armaflex Cellucar Insulation) LLC.
- C. No substitutions.

2.2 INSULATION MATERIALS

- A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:
 - 1. Preformed Pipe Insulation: Comply with ASTM C 547, Type I, with factory-applied, all-purpose, vapor-retardant jacket.
 - 2. Blanket Insulation: Comply with ASTM C553, Type II, without facing.
 - 3. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
 - a. Class I, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
 - b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
 - c. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 4. Vapor-Retarder Mastics: Fire and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C 19565C, Type II. See Paragraph 2.05 of this Section.
 - 5. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
 - 6. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.
 - 7. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
- B. Cellular-Glass Insulation: Inorganic, foamed or cellulated glass, annealed, rigid, hermetically sealed cells, incombustible.
 - 1. Preformed Pipe Insulation, without Jacket: Comply with ASTM C 552, Type II, Class I.
 - 2. Preformed Pipe Insulation, with Jacket: Comply with ASTM C 552, Type II, Class 2.
 - 3. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in performing insulation to cover valves, elbows, tees, and flanges.

2.3 FIELD-APPLIED JACKETS

- A. General: ASTM C 921, Type I, unless otherwise indicated.

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- B. Foil and Paper Jacket: Not acceptable.
- C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.
 - 1. Adhesive: As recommended by insulation material manufacturer.
 - 2. PVC Jacket Color: White
 - 3. PVC Jacket Color: Color-code piping jacket as determined by existing conditions.
 - 4. Not to be used for outdoors.
- D. Heavy PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 30-mil (0.75 mm) thick, high-impact, ultraviolet-resistant PVC.
 - 1. Shapes: 45 and 90-degree, short and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
 - 2. Adhesive: As recommended by insulation material manufacturer.
 - 3. Not to be used for outdoors.
- E. Aluminum Jacket: Aluminum roll stock, ready for shop or field cutting and forming to indicated sizes. Comply with ASTM B 209 (ASTM B 209M), 3003 alloy, H-14 temper.
 - 1. Finish and Thickness: Smooth finish, 0.010 (0.25 mm) inch thick.
 - 2. Moisture Barrier: 1-mil thick, heat-bonded polyethylene and kraft paper.
 - 3. Elbows: preformed 45 and 90-degree, short and long-radius elbows; same material, finish, and thickness as jacket.

2.4 ACCESSORIES AND ATTACHMENTS

- A. Bands: stainless steel ASTM A666, Type 304, 3/4 inch (20 mm) wide; 0.02 inch (0.050 mm) thick.

2.5 VAPOR RETARDANTS

- A. Mastics: Use materials as recommended by the insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.
- B. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of <Insert value> g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 SEALANTS

- A. Joint Sealants:
 - 1. For indoor applications, use mastics that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 -- EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Install materials after piping has been tested and approved.
- B. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS.

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.
- B. Refer to schedules at the end of this Section for material, form, jacket, and thickness required for each piping system insulation requirements.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften or otherwise attack insulation or jacket when in either wet or dry state.
- D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- E. Apply multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Seal joints and seams with vapor-retardant mastic on insulation indicated to receive a vapor retardant.
- H. Keep insulation materials dry during application and finishing.
- I. Apply insulation with tight longitudinal seams and end joints. Bond the seams and joints with adhesive recommended by the insulation material manufacturer.
- J. Apply insulation with the least number of joints practical.
- K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retardant integrity, unless otherwise indicated. Refer to special instruction for applying insulation over fittings, valves, and specialties.
- L. Hangers and Anchors: Where vapor retardant is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retardant mastic.

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1. Apply insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor retardants are indicated, extend insulation on anchor legs at least 12 inches (300 mm) from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retardant integrity.
 3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.
- M. Insulation Terminations: For insulation where vapor retardants are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retardant integrity.
- N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.
- O. Apply insulation with integral jackets as follows:
1. Pull jacket tight and smooth.
 2. Circumferential Joints: Cover with 3 inches (75 mm) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4-inches o.c.
 3. Longitudinal Seams: Overlap jacket seams at least 1 1/2 inches (38 mm). Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4-inches o.c.
 4. Exception: Do not staple longitudinal laps on insulation having a vapor retardant.
 5. Vapor-retardant mastics: Where vapor retardants are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
 6. At penetrations in jackets for thermometers and pressure gauges, fill and seal voids with vapor-retardant mastic.
- P. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
- Seal penetrations with vapor-retardant mastic.
1. Apply insulation for exterior applications tightly joined to interior insulation ends.
 2. Extend metal jacket for exterior insulation occurring outside of roof flashing at least 2-inches below the top of the roof flashing.
 3. Seal sheet metal jacket to roof flashing with vapor-retardant mastic.
- Q. Exterior Wall Penetrations: For penetration of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retardant mastic.
- R. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.
- S. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions

1. Firestopping and fire-resistive joint sealers are specified in Division 07 "Penetration Firestopping".
2. Floor Penetrations: Apply insulation continuously through floor assembly.
3. For insulation with vapor retardants, seal insulation with vapor-retardant mastic where floor supports penetrate vapor retardant.

3.4 MINERAL-FIBER INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
 1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
 2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20-feet (4.5 to 6 m) to form a vapor retarder between pipe insulation segments.
 3. For insulation with factory-applied jackets, secure laps with outward clinches staples at 6 inches o.c.
 4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
- B. Apply Insulation to flanges as follows:
 1. Apply preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch (25 mm), and seal joints with vapor-retarder mastic.
- C. Apply insulation to fittings and elbows as follows:
 1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When premolded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
 3. Cover fittings with heavy PVC covers. Overlap PVC covers on pipe insulation jackets at least 1 inch (25 mm) at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
- D. Apply insulation to valves and specialties as follows:
 1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When premolded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
 3. Apply insulation to flanges as specified for flange insulation application.
 4. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

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5. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.5 CELLULAR-GLASS INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
 1. Secure each layer of insulation to pipe with bands without deforming insulation.
 2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic.
 3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6-inches o.c.
 4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
- B. Apply insulation to flanges as follows:
 1. Apply preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of the same thickness as pipe insulation
 4. Apply insulation to fittings and elbows as follows:
 5. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instruction.
 6. When premolded sections of insulation are not available, apply mitered sections of cellular-glass insulation. Secure insulation materials with bands.
 7. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets as least 1 inch (25 mm) at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
- C. Apply insulation to valves and specialties as follows:
 1. Apply premolded segments of cellular-glass insulation or glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
 2. Apply insulation to flanges as specified for flange insulation application.
 3. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
 4. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.6 PREFORMED ELASTOMERIC CELLULAR THERMAL INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
 1. Install pipe insulation by slitting tubular sections and applying onto pipes. Seams and butt joints shall be adhered and sealed using Armaflex 520 adhesive

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2. All edges shall be clean-cut. Rough or jagged edges shall not be permitted.
- B. Apply insulation to valves, flanges and fittings as follows:
1. Insulate with the same insulation thickness as the adjacent piping. Seams and butt joints shall be adhered and sealed with Armaflex 520 adhesive.

All edges shall be clean-cut. Rough or jagged edges shall not be permitted.

- C. Outdoor insulation shall be protected as follows:
1. Furnish PVC jacket and PVC fitting covers or aluminum jackets.
 2. All jackets shall have the seams located on the bottom of the pipes.

3.7 FIELD-APPLIED JACKET APPLICATION

- A. Apply PVC jacket where indicated, with 1 inch (25 mm) overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
- B. Apply metal jacket where indicated, with 2-inch (50 mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel band 12 inches (300 mm) o.c. and at end joints.
- C. Insulation and jacket for cold pipes shall include wicks to direct possible condensation to outside the jacket. The product shall be Knauf PermaWick or equal.
- D. Indoor, Concealed Applications: Insulated pipes conveying fluids above ambient temperature shall have standard jackets, with or without vapor barrier, factory-applied or field-applied. Insulate fittings, joints and valves with insulation of like material and thickness as adjoining pipe, and finish with glass cloth and adhesive. PVC jackets shall be used.
- E. Indoor, Exposed Applications: For pipe exposed in mechanical equipment rooms or in finished spaces, insulate as for concealed applications. Finish with canvas jacket; size for finish painting. PVC jackets shall be used.
- F. Exterior Applications: Provide vapor-barrier jackets. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe and cover with aluminum jacket.
- G. Buried Piping: Provide factory-fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt-impregnated open-mesh glass fabric, with 0.001 inch thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

3.8 FINISHES

- A. Paint insulation as specified in Section 09 90 00 – Painting.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

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3.9 PIPING SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment.
 - 1. Flexible connectors.
 - 2. Vibration control devices.
 - 3. Fire-suppression piping.
 - 4. Drainage piping located in crawl spaces, unless otherwise indicated.
 - 5. Below-grade piping, unless otherwise indicated.
 - 6. Chrome-plated pipes and fittings, unless potential for personal injury.
 - 7. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.10 INSULATION APPLICATION SCHEDULE, GENERAL.

- A. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.
- B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.11 INTERIOR INSULATION APPLICATION SCHEDULE

- A. Service: Domestic and Industrial hot water.203.2 mm
 - 1. Operating Temperature: 60 to 140 deg F (15.6 to 60 deg C).
 - 2. Insulation Material: Mineral-fiber
 - 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Copper Pipe, Up to 2 inches (50.8 mm): 1 inch (25 mm) Insulation
 - 4. Field-Applied Jacket: PVC
 - 5. Vapor Retarder Required: Yes
 - 6. Finish: As specified in Paragraph 3.08 of this Section.
- B. Service: Chilled-water supply and return.
 - 1. Operating Temperature: 35 to 75 deg F (2 to 24 deg C).
 - 2. Insulation Material: Mineral-fiber
 - 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Steel Pipe, All sizes: 1 inch (25 mm) Insulation
 - b. Copper All sizes: 1 inch (25 mm) Insulation
 - 4. Field-Applied Jacket: PVC
 - 5. Vapor Retarder Required: Yes
 - 6. Finish: As specified in Paragraph 3.08 of this Section.
- C. Service: Heating hot-water supply and return.
 - 1. Operating Temperature: 100 to 200 deg F (38 to 93 deg C).
 - 2. Insulation Material: Mineral-fiber
 - 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Steel Pipe, Up to 2 inches (50.8 mm): 1 inch (25 mm) Insulation
 - b. Copper Pipe, Up to 2 inches (50.8 mm): 1 inch (25 mm) Insulation

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- c. Steel Pipe, 2 1/4 inches (57.2 mm) to 6 inches (152.4 mm): 1 1/2 inch (38 mm) Insulation
 - d. Copper Pipe, 2 1/4 inches (57.2 mm) to 6 inches (152.4 mm): 1 1/2 inch (38 mm) Insulation
 - 4. Field-Applied Jacket: PVC
 - 5. Vapor Retarder Required: Yes
 - 6. Finish: As specified in Paragraph 3.08 of this Section.
- D. Service: Steam and Condensate:
- 1. Operating Temperature: 450 deg F (232 deg C) and lower
 - 2. Insulation Material: Mineral-fiber or Calcium Silicate
 - 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Steel Pipe, Steam Up to 2 inches (50.8 mm): 1 1/2 inch (38 mm) Insulation
 - b. Steel Pipe, Steam 2 1/4 inches (57.2 mm) to 4 inches (101.6 mm): 3 inches (75 mm) Insulation
 - c. Steel Pipe, Condensate Up to 2 inches (50.8 mm) : 1 1/2 inch (38 mm) Insulation
 - 4. Field-Applied Jacket: Aluminum
 - 5. Vapor Retarder Required: No
 - 6. Finish: As specified in Paragraph 3.08 of this Section.
- E. Service: Process Cold Water - (Industrial):
- 1. Operating Temperature: 30 deg F (1.1 deg C)
 - 2. Insulation Material: Mineral-fiber
 - 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Copper Pipe, All Sizes: 1 inch (25 mm) Insulation
 - 4. Field-Applied Jacket: PVC
 - 5. Vapor Retarder Required: Yes
 - 6. Finish: As specified in Paragraph 3.08 of this Section.
- F. EXTERIOR INSULATION APPLICATION SCHEDULE
- G. This application schedule is for aboveground insulation outside the building.
- H. Service: Domestic, industrial and DI Water.
- 1. Operating Temperature: 60 to 140 deg F (15 to 60 deg C).
 - 2. Insulation Material: Mineral-fiber
 - 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Copper pipe, All sizes: 1 inch (25 mm) Insulation
 - b. Polypropylene Pipe 1 inch (25 mm) Insulation
 - 4. Field-Applied Jacket: Aluminum
 - 5. Vapor Retarder Required: Yes
 - 6. Finish: As specified in Paragraph 3.08 of this Section.
- I. Service: Chilled-water supply and return.
- 1. Operating Temperature: 35 to 75 deg F (2 to 24 deg C).
 - 2. Insulation Material: Mineral-fiber
 - 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Steel pipe, All sizes: 1 1/2 inch (38 mm) Insulation
 - b. Copper Pipe, All sizes: 1 1/2 inch (38 mm) Insulation

4. Field-Applied Jacket: Aluminum
5. Vapor Retarder Required: Yes
6. Finish: As specified in Paragraph 3.08 of this Section.

J. Service: Heating hot-water supply and return.

1. Operating Temperature: 100 to 220 deg F (38 to 104 deg C)
2. Insulation Material: Mineral Fiber
3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Steel Pipe, All sizes: 1 1/2 inch (38 mm) Insulation
 - b. Copper Pipe, All sizes: 1 1/2 inch (38 mm) Insulation
4. Field-Applied Jacket: Aluminum
5. Vapor Retarder Required: Yes
6. Finish: As specified in Paragraph 3.08 of this Section.

K. Service: Steam and condensate.

1. Operating Temperature: 450 deg F (232 deg C) and lower.
2. Insulation Material: Mineral Fiber
3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Steel Pipe, Steam Up to 2 inches (50.8 mm): 2 1/2 inch (63 mm) Insulation
 - b. Steel Pipe, Steam 2 1/4 inches (57.2 mm) to 8 inches (203.2 mm): 3 1/2 inch (89 mm) Insulation
 - c. Steel Pipe, Condensate Up to 2 inches (50.8 mm): 1 1/2 inch (38 mm) Insulation
 - d. Steel Pipe, Condensate 2 1/4 inches (57.2 mm) to 8 inches (203.2 mm): 2 inches (50.8 mm) Insulation
4. Field-Applied Jacket: Aluminum
5. Vapor Retarder Required: Yes
6. Finish: As specified in Paragraph 3.08.

3.12 ALTERNATE INSULATION APPLICATION

- A. Preformed elastomeric cellular insulation may be used as an alternative to the materials in Paragraphs 3.12 and 3.13 of this Section.

-END OF SECTION-

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SECTION 15404

FACILITY WATER DISTRIBUTION PIPING

PART 1 -- GENERAL

1.1 DESCRIPTION

- A. Domestic water systems, including piping, equipment and all necessary accessories as designated in this Section.
- B. A complete listing of all acronyms and abbreviations are included in Section 15400 – Common Results for Plumbing.

1.2 RELATED WORK

- A. Section 01000 – General Specifications
- B. Section 01300 – Submittal Procedures
- C. Section 07900 – Joint Fillers, Sealants and Caulking
- D. Section 09900 – Painting
- E. Section 15400 – Common Results for Plumbing
- F. Section 15403 – Plumbing Piping Insulation

1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
 - 1. A13.1-2007 (R2013) – Scheme for Identification of Piping Systems
 - 2. B16.3-2011 – Malleable Iron Threaded Fittings: Classes 150 and 300
 - 3. B16.9-2012 – Factory-Made Wrought Butt Welding Fittings
 - 4. B16.11-2011 – Forged Fittings, Socket-Welding and Threaded
 - 5. B16.12-2009 (R2014) – Cast Iron Threaded Drainage Fittings
 - 6. B16.15-2013 – Cast Copper Alloy Threaded Fittings: Classes 125 and 250
 - 7. B16.18-2012 – Cast Copper Alloy Solder Joint Pressure Fittings
 - 8. B16.22-2013 – Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
 - 9. B16.24-2011 – Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500
 - 10. B16.51-2013 – Copper and Copper Alloy Press-Connect Fittings
 - 11. ASME Boiler and Pressure Vessel Code
 - 12. BPVC Section IX-2015 Welding, Brazing, and Fusing Qualifications

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C. American Society of Sanitary Engineers (ASSE):

1. 1010-2004 – Performance Requirements for Water Hammer Arresters

D. American Society for Testing and Materials (ASTM):

A47/A47M-1999 (R2014) – Standard Specification for Ferritic Malleable Iron Castings

1. A53/A53M-2012 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
2. A183-2014 – Standard Specification for Carbon Steel Track Bolts and Nuts
3. A269/A269M-2014e1 – Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
4. A312/A312M-2015 – Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
5. A403/A403M-2014 – Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
6. A536-1984 (R2014) – Standard Specification for Ductile Iron Castings
7. A733-2013 – Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
8. B32-2008 (R204) – Standard Specification for Solder Metal
9. B43-2014 – Standard Specification for Seamless Red Brass Pipe, Standard Sizes
10. B61-2008 (R2013) – Standard Specification for Steam or Valve Bronze Castings
11. B62-2009 – Standard Specification for Composition Bronze or Ounce Metal Castings
12. B75/B75M-2011 – Standard Specification for Seamless Copper Tube
13. B88-2014 – Standard Specification for Seamless Copper Water Tube
14. B584-2014 – Standard Specification for Copper Alloy Sand Castings for General Applications
15. B687-1999 (R2011) – Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples
16. C919-2012 – Standard Practice for Use of Sealants in Acoustical Applications
17. D1785-2012 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
18. D2000-2012 – Standard Classification System for Rubber Products in Automotive Applications
19. D2564-2012 – Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems
20. D2657-2007 – Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
21. ASTM D 2765 – Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics.
22. ASTM D 6394 – Specification for Sulfone Plastics (SP).
23. ASTM E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
24. ASTM E 119 – Standard Test Methods for Fire Tests of Building Construction and Materials.
25. ASTM E 814 – Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
26. ASTM F 876 – Standard Specification for Crosslinked Polyethylene (PEX) Tubing.

27. ASTM F 877 – Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems.
 28. ASTM F 1960 – Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Crosslinked Polyethylene (PEX) Tubing
 29. D2855-1996 (R2010) – Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
 30. D4101-2014 – Standard Specification for Polypropylene Injection and Extrusion Materials
 31. E1120-2008 – Standard Specification for Liquid Chlorine
 32. E1229-2008 – Standard Specification for Calcium Hypochlorite
 33. F2389-2010 – Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems
 34. F2620-2013 – Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
 35. F2769-2014 – Standard Specification for Polyethylene of Raised Temperature (PE-RT) Plastic Hot and Cold-Water Tubing and Distribution Systems
- E. American Water Works Association (AWWA):
1. C110-2012 – Ductile-Iron and Gray-Iron Fittings
 2. C151-2009 – Ductile Iron Pipe, Centrifugally Cast
 3. C153-2011 – Ductile-Iron Compact Fittings
 4. C203-2008 – Coal-Tar Protective Coatings and Linings for Steel Water Pipelines – Enamel and Tape – Hot Applied
 5. C213-2007 – Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
 6. C651-2014 – Disinfecting Water Mains
- F. American Welding Society (AWS):
1. A5.8M/A5.8-2011-AMD1 – Specification for Filler Metals for Brazing and Braze Welding
- G. International Code Council (ICC):
1. IPC-2012 – International Plumbing Code
- H. Manufacturers Specification Society (MSS):
1. SP-58-2009 – Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation
 2. SP-72-2010a – Ball Valves with Flanged or Butt-Welding Ends for General Service
 3. SP-110-2010 – Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
- I. NSF International (NSF):
1. 14-2015 – Plastics Piping System Components and Related Materials
 2. 61-2014a – Drinking Water System Components – Health Effects
 3. 372-2011 – Drinking Water System Components – Lead Content
- J. Plumbing and Drainage Institute (PDI):
- a. PDI-WH 201-2010 – Water Hammer Arrestors

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- K. Department of Veterans Affairs:
 - 1. H-18-8-2013 – Seismic Design Handbook

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01300 – Submittal Procedures.
- B. Information and material submitted under this Section shall be marked “SUBMITTED UNDER SECTION 22 11 13 – FACILITY WATER DISTRIBUTION PIPING”, with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.

All items listed in Part 2 - Products.

- D. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replacement parts:
 - 1. Include complete list indicating all components of the systems.
 - 2. Include complete diagrams of the internal wiring for each item of equipment.
 - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.

1.5 QUALITY ASSURANCE

- A. A certificate shall be submitted prior to welding of steel piping showing the Welder’s certification. The certificate shall be current and no more than one year old. Welder’s qualifications shall be in accordance with ASME BPVC Section IX.
- B. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be by the same manufacturer as the groove components.
- C. All pipe, couplings, fittings, and specialties shall bear the identification of the manufacturer and any markings required by the applicable referenced standards.

1.6 SPARE PARTS

- A. For mechanical press-connect fittings, provide tools required for each pipe size used at the facility.

1.7 AS-BUILT DOCUMENTATION

- A. Submit manufacturer’s literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc or DVD

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inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A list of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD version 2017 provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- D. Certification documentation shall be provided to Owner's Representative 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certificate if applicable that all results of tests were within limits specified. If a certificate is not available, all documentation shall be on the Certifier's letterhead.

PART 2 -- PRODUCTS

2.1 MATERIALS

- A. Material or equipment containing a weighted average of greater than 0.25 percent lead are prohibited in any potable water system intended for human consumption and shall be certified in accordance with NSF 61 or NSF 372. Endpoint devices used to dispense water for drinking shall meet the requirements of NSF 61, Section 9.
- B. Plastic pipe, fittings, and solvent cement shall meet NSF 14 and shall be NSF listed for the service intended.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A), water tube, drawn temper.
 - 1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
- B. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
- C. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

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2.3 PVC PIPE AND FITTINGS

- A. PVC, Schedule 40 Pipe: ASTM D 1785.
 - 1. PVC, Schedule 40 Socket Fittings: ASTM D 2466.
- B. PVC, Schedule 80 Pipe: ASTM D 1785.
 - 1. PVC, Schedule 80 Socket Fittings: ASTM D 2467.
 - 2. PVC, Schedule 80 Threaded Fittings: ASTM D 2464.
- C. PVC, AWWA Pipe: AWWA C900, Class 150, with bell end with gasket, and with spigot end.
 - 1. Comply with UL 1285 for fire-service mains if indicated.
 - 2. PVC Fabricated Fittings: AWWA C900, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 - 3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 - 4. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Gaskets: AWWA C111, rubber.
 - 5. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.4 CPVC PIPE AND FITTINGS

- A. CPVC Schedule 80 Pipe: ASTM F441/F 441M.
 - 1. CPVC Schedule 40 Fittings: ASTM F438, socket type.
 - 2. CPVC Schedule 80 Fittings: ASTM F439, socket, ASTM F437, threaded, ASTM F439, socket type or ASTM F437, threaded type.

2.5 PEX PIPE AND FITTINGS

- A. PEX-a (Engel-method crosslinked polyethylene) piping: ASTM F 876 and F877 (CAN/CSA-B137.5) by Uponor.
- B. PEX-a Fittings: elbows, adapters, couplings, plugs, tees and multi-port tees (1/2 inch through 3 inch nominal pipe size): ASTM F1960 cold-expansion fitting manufactured from the following material types:
 - 1. UNS No. C69300 lead-free (LF) brass.
 - 2. UNS No. C27453 lead-free (LF) brass.
 - 3. 20% Glass-filled Polysulfone as specified in ASTM D 6394.
 - 4. Unreinforced Polysulfone (Group 01, Class 1, Grade 2) as specified in ASTM D 6394.
 - 5. Polyphenylsulfone (Group 03, Class 1, Grade 2) as specified in ASTM D 6394.
 - 6. Blend of polyphenylsulfone (55-80%) and unreinforced Polysulfone (REM.) as specified in ASTM D 6394.
 - 7. Reinforcing cold-expansion rings shall be manufactured from the same source as PEX-a piping manufacturer and marked "F1960".

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- C. Pre-sleeved piping (1/2 inch (16mm) through 3/4 inch (20mm) nominal pipe size): PEX-a piping, with a high-density polyethylene (HDPE) corrugated sleeve.
- D. Pre-insulated piping (1/2 inch (16mm) through 2 inch (50mm) nominal pipe size): PEX-a piping, with a closed-cell polyethylene foam insulation.
- E. Multi-port tees: multiple-outlet fitting complying with ASTM F 877 (CAN/CSA B137.5); with ASTM F 1960 inlets and outlets.
 - 1. Engineered polymer branch multi-port tee.
 - 2. Engineered polymer flow-through multi-port tee.
 - 3. Engineered polymer commercial branch multi-port tee.
 - 4. Engineered polymer commercial branch multi-port elbow.
 - 5. Engineered polymer commercial flow-through multi-port tee.
- F. Manifolds: multiple-outlet assembly complying with ASTM F 877 (CAN/CSA B137.5); with ASTM F 1960 outlets.
 - 1. Engineered polymer valved manifold.
 - 2. Engineered polymer valveless manifold.
 - 3. Lead - free copper branch manifold.
 - 4. Lead-free copper valved manifold.

2.6 TRAP PRIMER WATER PIPING

- A. Pipe: Copper tube, ASTM B88, type K, hard drawn.
- B. Fittings: Bronze castings conforming to ASME B16.18 Solder joints.
- C. Solder: ASTM B32 alloy type Sb5. Provide non-corrosive flux.

2.7 STRAINERS

- A. Provide on high pressure side of pressure reducing valves, on suction side of pumps, on inlet side of indicating and control instruments and equipment subject to sediment damage and where shown on drawings. Strainer element shall be removable without disconnection of piping.
- B. Water: Basket or "Y" type with easily removable cover and brass strainer basket.
- C. Body: Less than 3 inches, brass or bronze; 3 inches and greater, cast iron or semi-steel.

2.8 DIELECTRIC FITTINGS

- A. Provide dielectric couplings or unions between pipe of dissimilar metals.

2.9 STERILIZATION CHEMICALS

- A. Hypochlorite: ASTM E1120.
- B. Liquid Chlorine: ASTM E1229.

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2.10 WATER HAMMER ARRESTER

1. Closed copper tube chamber with permanently sealed 60 psig air charge above a Double O-ring piston. Two high heat Buna-N O-rings pressure packed and lubricated with FDA approved silicone compound. All units shall be designed in accordance with ASSE 1010. Access shall be provided where devices are concealed within partitions or above ceilings. Size and install in accordance with PDI-WH 201 requirements. Provide water hammer arrestors at:
 2. All solenoid valves.
 3. All groups of two or more flush valves.
 4. All quick opening or closing valves.
 5. All medical washing equipment.

2.11 TRANSITION FITTINGS

A. PEX-to-Metal Transition Fittings:

1. Manufacturers: Provide fittings from the same manufacturer of the piping.
2. PEX-a to Threaded Brass Transition: One-piece brass fitting with male or female threaded adapter and ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
3. PEX-a to Brass Sweat Transition: One-piece brass fitting with sweat adapter and ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
4. PEX-a to Flange Transition: Two-piece fitting with one steel flange conforming to ASME B 16.5 and one lead free (LF) brass adapter conforming to ASTM F 1960.
5. PEX-a to Groove Transition: One-piece lead free (LF) brass fitting with one CSA B242-05 groove end in either iron pipe size (IPS) or copper tube size (CTS) and one ASTM F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
6. PEX-a to Water Meter Transition: Two-piece fitting with one NPSM union thread and one ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
7. PEX-a to Copper Press Transition: One-piece lead free (LF) brass fitting with one ASME B16.51 copper press end and one ASTM F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
8. PEX-to-Thermoplastic Transition Fittings:
9. PEX-a to CPVC Transition: Thermoplastic fitting with one spigot or socket end and one ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. General: Comply with the International Plumbing Code and the following:

1. Install branch piping for water from the piping system and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Owner or specified in other sections.
2. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, except for plastic and glass, shall be reamed to remove burrs and a clean smooth finish restored to full pipe inside diameter.
3. All pipe runs shall be laid out to avoid interference with other work/trades.
4. Install union and shut-off valve on pressure piping at connections to equipment.

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5. Install chrome plated cast brass escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
 6. Penetrations:
 - a. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in Section 07900 – Joint Fillers, Sealants and Caulking. Bio-based materials shall be utilized when possible.
 - b. Acoustical sealant: Where pipes pass through sound rated walls, seal around the pipe penetration with an acoustical sealant that is compliant with ASTM C919.
 7. Mechanical press-connect fitting connections shall be made in accordance with the manufacturer’s installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. Ensure the tube is completely inserted to the fitting stop (appropriate depth) and squared with the fitting prior to applying the pressing jaws onto the fitting. The joints shall be pressed using the tool(s) approved by the manufacturer. Minimum distance between fittings shall be in accordance with the manufacturer’s requirements. When the pressing cycle is complete, visually inspect the joint to ensure the tube has remained fully inserted, as evidenced by the visible insertion mark.
- B. Domestic Water piping shall conform to the following:
- 3.2 Grade all lines to facilitate drainage. Provide drain valves at bottom of risers and all low points in system. Design domestic hot water circulating lines with no traps.
 - 3.3 Connect branch lines at bottom of main serving fixtures below and pitch down so that main may be drained through fixture. Connect branch lines to top of main serving only fixtures located on floor above.
 - 3.4 PIPING SCHEDULE
 - A. Underground water-service piping NPS 3/4 to NPS 3 shall be any of the following:
 1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); [wrought-copper, solder-joint fittings; and brazed joints.
 2. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented joints.
 3. PEX-a, cross linked polyethylene pipe with cold expansion fittings.
 - B. Aboveground Water-Service Piping [NPS 3/4 to NPS 3] shall be any of the following:
 1. Hard copper tube, [ASTM B 88, Type K (ASTM B 88M, Type A)] [ASTM B 88, Type L (ASTM B 88M, Type B)]; wrought-copper, solder-joint fittings; and brazed joints.
 2. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented joints.

3. CPVC, Schedule 80 pipe; CPVC, Schedule 80 socket fittings; and solvent-cemented joints.
4. NPS 1 to NPS 2 PEX with cold expansion joints.

3.5 CORROSION RESISTANT COATING

- A. All copper pipe shall receive a corrosion resistant coating. For piping that receives insulation, the coating shall be applied and allowed to cure per the manufacturer's instructions prior to insulating.
- B. Coating shall be a field applied Bronz-Glow's SPC-Clear coating, Incralac or approved equal. The coating shall be specifically listed for use on copper pipe for the protection from corrosion due to hydrogen sulfide and shall be UV resistant.

3.6 TESTS

- A. General: Test system either in its entirety or in sections. Submit testing plan to Owner's Representative 10 working days prior to test date.
- B. Potable Water System: Test after installation of piping and domestic water heaters, but before piping is concealed, before covering is applied, and before plumbing fixtures are connected. Fill systems with water and maintain hydrostatic pressure of 150 psig gauge for two hours. No decrease in pressure is allowed. Provide a pressure gauge with a shutoff and bleeder valve at the highest point of the piping being tested. Pressure gauge shall have 1 psig increments.
- C. All Other Piping Tests: Test new installed piping under 1-1/2 times actual operating conditions and prove tight.
- D. The test pressure shall hold for the minimum time duration required by the applicable plumbing code or authority having jurisdiction.

3.7 STERILIZATION

- A. After tests have been successfully completed, thoroughly flush and sterilize the interior domestic water distribution system in accordance with AWWA C651.
- B. Use liquid chlorine or hypochlorite for sterilization.

-END OF SECTION-

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SECTION 15405

DOMESTIC WATER PIPING SPECIALTIES

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the following domestic water piping specialties:
 - 1. Vacuum breakers
 - 2. Backflow preventers
 - 3. Balancing valves
 - 4. Strainers
 - 5. Outlet boxes
 - 6. Hose bibbs
 - 7. Wall hydrants
 - 8. Drain valves
 - 9. Water hammer arresters
 - 10. Air vents
 - 11. Trap-seal primer valves
- B. Related Sections include the following:
 - 1. Section 22 05 19 Meters and Gauges for Plumbing Piping for thermometers, pressure gauges, and flow meters in domestic water piping.

1.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For domestic water piping specialties to include operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NSF Compliance:

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1. Comply with NSF 14, Plastics Piping Components and Related Materials, for plastic domestic water piping components.
2. Comply with NSF 61, Drinking Water System Components Health Effects; Sections 1 through 9.

PART 2 – PRODUCTS

2.1 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 1. Manufacturers:
 - a. Conbraco Industries, Inc.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 2. Standard: ASSE 1001.
 3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
 4. Body: Bronze.
 5. Inlet and Outlet Connections: Threaded.
 6. Finish: Chrome plated.
- B. Hose-Connection Vacuum Breakers:
 1. Manufacturers:
 - a. Conbraco Industries, Inc.
 - b. MIFAB, Inc.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Woodford Manufacturing Company.
 - e. Zurn Plumbing Products Group.
 2. Standard: ASSE 1011.
 3. Body: Bronze, nonremovable, with manual drain.
 4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
 5. Finish: Chrome or Rough bronze.
- C. Pressure Vacuum Breakers:
 1. Manufacturers:
 - a. Conbraco Industries, Inc.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 2. Standard: ASSE 1020.
 3. Operation: Continuous-pressure applications.
 4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
 5. Accessories:
 - a. Valves: Ball type, on inlet.
- D. Laboratory-Faucet Vacuum Breakers:
 1. Manufacturers:
 - a. Conbraco Industries, Inc.
 - b. Watts Industries, Inc.; Water Products Div.

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- c. Woodford Manufacturing Company.
- d. Zurn Plumbing Products Group; Wilkins Div.
- 2. Standard: ASSE 1035.
- 3. Size: NPS 1/4 or NPS 3/8 matching faucet size.
- 4. Body: Bronze.
- 5. End Connections: Threaded.
- 6. Finish: Chrome plated.

E. Spill-Resistant Vacuum Breakers:

- 1. Manufacturers:
 - a. Conbraco Industries, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
- 2. Standard: ASSE 1056.
- 3. Operation: Continuous-pressure applications.
- 4. Accessories:
 - a. Valves: Ball type, on inlet.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

- 1. Manufacturers:
 - a. Conbraco Industries, Inc.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
- 2. Standard: ASSE 1013.
- 3. Operation: Continuous-pressure applications.
- 4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
- 5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or steel with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
- 6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
- 7. Configuration: Designed for horizontal, straight through flow.
- 8. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.3 BALANCING VALVES

A. Automatic Balancing Valves:

- 1. Manufacturers:
 - a. Flow Design, Inc.
 - b. Griswold Controls
- 2. Type: Ball valve with two readout ports and stainless steel flow regulating cartridge.
- 3. Body: Brass.
- 4. Size: Same as connected piping, but not larger than NPS 2.
- 5. Pressure Rating: 400-psig minimum CWP.
- 6. Ball: Chrome-plated brass.

7. Seats and Seals: Replaceable.
8. End Connections: Solder joint or threaded.
9. Handle: Vinyl-covered steel.
10. Accuracy: plus or minus 5%

2.4 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2) and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
 - c. Strainers NPS 5 and Larger: 0.10 inch.
6. Drain: Factory-installed, hose-end drain valve.

2.5 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

1. Manufacturers:
 - a. Acorn Engineering Company.
 - b. Guy Gray Manufacturing Co., Inc.
 - c. IPS Corporation. (Guy Gray)
 - d. Oatey.
 - e. Symmons Industries, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Whitehall Manufacturing; a div. of Acorn Engineering Company.
 - h. Zurn Plumbing Products Group.
2. Mounting: Recessed.
3. Material and Finish: Epoxy-painted-steel box and faceplate.
4. Faucet: Combination, valved fitting or separate hot- and cold-water, valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
5. Supply Shutoff Fittings: NPS 1/2 ball valves and NPS 1/2 copper, water tubing.
6. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.

B. Icemaker Outlet Boxes:

1. Manufacturers:
 - a. Acorn Engineering Company.
 - b. IPS Corporation. (Guy Gray)
 - c. Oatey.
2. Mounting: Recessed.
3. Material and Finish: Epoxy-painted-steel box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 ball valve and NPS 1/2 copper, water tubing.

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2.6 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Refer to Plumbing Fixture Schedule on drawings for finishes.

2.7 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Woodford Manufacturing Company.
 - g. Zurn Plumbing Products Group.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
9. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
10. Operating Keys(s): One with each wall hydrant.
11. Refer to Plumbing Fixture Schedule on drawings for finishes.

B. Nonfreeze, Hot- and Cold-Water Wall Hydrants:

1. Manufacturers:
 - a. Josam Company.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Tyler Pipe; Wade Div.
 - d. Watts Drainage Products Inc.
 - e. Woodford Manufacturing Company.
 - f. Zurn Plumbing Products Group.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.

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5. Casings and Operating Rods: Of length required to match wall thickness. Include wall clamps.
6. Inlets: NPS 3/4 or NPS 1.
7. Outlet: Concealed.
8. Box: Deep, flush mounting with cover.
9. Vacuum Breaker: Nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052 and with garden-hose thread complying with ASME B1.20.7 on outlet.
10. Operating Keys(s): One with each wall hydrant.
11. Refer to Plumbing Fixture Schedule on drawings for finishes.

2.8 DRAIN VALVES

- A. Ball-Valve-Type, Hose-End Drain Valves:
1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
 2. Pressure Rating: 400-psig minimum CWP.
 3. Body: Copper alloy.
 4. Ball: Chrome-plated brass.
 5. Seats and Seals: Replaceable.
 6. Handle: Vinyl-covered steel.
 7. Inlet: Threaded or solder joint.
 8. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.9 WATER HAMMER ARRESTERS

- A. Water Hammer Arresters:
1. Manufacturers:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. PPP Inc.
 - d. Sioux Chief Manufacturing Company, Inc.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products Inc.
 - g. Zurn Plumbing Products Group.
 2. Standard: ASSE 1010 or PDI-WH 201.
 3. Type: Copper tube with piston.
 4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.10 AIR VENTS

- A. Bolted-Construction Automatic Air Vents:
1. Body: Bronze.
 2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
 3. Float: Replaceable, corrosion-resistant metal.
 4. Mechanism and Seat: Stainless steel.
 5. Inlet and Vent Outlet End Connections: Threaded.
- B. Welded-Construction Automatic Air Vents:
1. Body: Stainless steel.

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2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Inlet and Vent Outlet End Connections: Threaded.

2.11 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:

1. Manufacturers:
 - a. MIFAB, Inc.
 - b. PPP Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Distribution box as required.
8. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Refer to Section 22 05 0015400 □ Common Results for Plumbing for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 1. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 2. Do not install bypass piping around backflow preventers.
- C. Install balancing valves in locations where they can easily be adjusted.
- D. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.
- E. Install outlet boxes recessed in wall. Install 2-by-4-inch (38-by-89-mm) fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Section 06 10 00 □ Rough Carpentry.

- F. Install water hammer arresters in water piping according to PDI-WH 201 and drawings.
- G. Install air vents at high points of water piping. Install drain piping and discharge to floor drain.
- H. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 1522 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Ground equipment according to Section 26 05 26 □ Grounding and Bonding for Electrical Systems.
- C. Connect wiring according to Section 26 05 19 □ Low-Voltage Conductors and Cables.

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Pressure vacuum breakers.
 - 2. Intermediate atmospheric-vent backflow preventers.
 - 3. Reduced-pressure-principle backflow preventers.
 - 4. Double-check backflow-prevention assemblies.
 - 5. Automatic balancing valves.
 - 6. Outlet boxes.
 - 7. Supply-type, trap-seal primer valves.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 5315402 – Identification for Plumbing Piping and Equipment.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - 1. Test each pressure vacuum breaker reduced-pressure-principle backflow preventer, double-check backflow-prevention assembly and vacuum breaker assembly according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

- A. Confirm flow rate and direction of flow for automatic balancing valves.

-END OF SECTION

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SECTION 15406

SANITARY WASTE AND VENT PIPING

PART 1 --GENERAL

1.1 DESCRIPTION

- A. This Section pertains to sanitary sewer and vent systems, including piping, equipment and all necessary accessories as designated in this section.
- B. A complete listing of all acronyms and abbreviations are included in Section 15400 – Common Results for Plumbing.

1.2 RELATED WORK

- A. Section 01000 – General Specifications
- B. Section 01300 – Submittal Procedures
- C. Section 07900 – Joint Fillers, Sealants and Caulking: Sealant Products
- D. Section 09900 – Painting: Preparation and Finish Painting and Identification of Piping Systems.
- E. Section 15400 – Common Results for Plumbing: Pipe Hangers and Supports, Materials Identification.
- F. Section 15403 – Plumbing Piping Insulation
- G. Section 16170 – Grounding and Bonding for Electrical Systems

1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
 - 1. A13.1-2007 – Scheme for the Identification of Piping Systems
 - 2. A112.36.2M-1991(R 2012) – Cleanouts
 - 3. A112.6.3-2001 (R2007) – Standard for Floor and Trench Drains
 - 4. B1.20.1-2013 – Pipe Threads, General Purpose (Inch)
 - 5. B16.1-2010 – Gray Iron Pipe Flanges and Flanged Fittings
 - 6. B16.4-2011 – Standard for Grey Iron Threaded Fittings Classes 125 and 250
 - 7. B16.15-2013 – Cast Copper Alloy Threaded Fittings, Classes 125 and 250
 - 8. B16.18-2012 – Cast Copper Alloy Solder Joint Pressure Fittings
 - 9. B16.21-2011 – Nonmetallic Flat Gaskets for Pipe Flanges

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10. B16.22-2013 – Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
 11. B16.23-2011 – Cast Copper Alloy Solder Joint Drainage Fittings: DWV
 12. B16.24-2001 (R2006) – Cast Copper Alloy Pipe Flanges and Flanged Fittings
 13. B16.29-2012 – Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings: DWV
 14. B16.39-2009 – Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
 15. B18.2.1-2012 – Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
- C. American Society of Sanitary Engineers (ASSE):
1. 1001-2008 – Performance Requirements for Atmospheric Type Vacuum Breakers
 2. 1018-2001 – Performance Requirements for Trap Seal Primer Valves – Potable Water Supplied
 3. 1044-2001 – Performance Requirements for Trap Seal Primer Devices – Drainage Types and Electronic Design Types
 4. 1079-2012 – Performance Requirements for Dielectric Pipe Unions
- D. American Society for Testing and Materials (ASTM):
1. A53/A53M-2012 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-coated, Welded and Seamless
 2. A74-2013a – Standard Specification for Cast Iron Soil Pipe and Fittings
 3. A888-2013a – Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
 4. B32-2008 – Standard Specification for Solder Metal
 5. B43-2009 – Standard Specification for Seamless Red Brass Pipe, Standard Sizes
 6. B75-2011 – Standard Specification for Seamless Copper Tube
 7. B88-2009 – Standard Specification for Seamless Copper Water Tube
 8. B306-2013 – Standard Specification for Copper Drainage Tube (DWV)
 9. B584-2013 – Standard Specification for Copper Alloy Sand Castings for General Applications
 10. B687-1999 (R 2011) – Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples
 11. B813-2010 – Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
 12. B828-2002 (R 2010) – Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
 13. C564-2012 – Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
 14. D1785-2012 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
 15. D2321-2011 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
 16. D2564-2012 – Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
 17. D2665-2012 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
 18. D2855-1996 (R 2010) – Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings

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19. D5926-2011 – Standard Specification for Poly(Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems
 20. F402-2005 (R 2012) – Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
 21. F477-2010 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
 22. F1545-1997 (R 2009) – Standard Specification for Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges
- E. Cast Iron Soil Pipe Institute (CISPI):
1. 2006 – Cast Iron Soil Pipe and Fittings Handbook
 2. 301-2012 – Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
 3. 310-2012 – Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
- F. Copper Development Association, Inc. (CDA):
1. A4015 – Copper Tube Handbook
- G. International Code Council (ICC):
1. IPC-2012 – International Plumbing Code
- H. Manufacturers Standardization Society (MSS):
1. SP-123-2013 – Non-Ferrous Threaded and Solder-Joint Unions for Use With Copper Water Tube
- I. National Fire Protection Association (NFPA):
1. 70-2014 – National Electrical Code (NEC)
- J. Plumbing and Drainage Institute (PDI):
1. WH-201 (R 2010) – Water Hammer Arrestors Standard
- K. Underwriters' Laboratories, Inc. (UL):
1. 508-99 (R2013) – Standard for Industrial Control Equipment

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01300 – Submittal Procedures.
- B. Information and material submitted under this Section shall be marked “SUBMITTED UNDER SECTION 22 13 16 – SANITARY WASTE AND VENT PIPING”, with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
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2. Floor Drains
3. Grease Removal Unit
4. Cleanouts
5. Trap Seal Protection
6. Penetration Sleeves
7. Pipe Fittings
8. Traps
9. Exposed Piping and Fittings

- D. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane or the floor drain.

1.5 AS-BUILT DOCUMENTATION

- A. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them on Auto-Cad version 2017 provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the ‘third party testing company’ requirement.
- B. Certification documentation shall be provided prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and a certification that all results of tests were within limits specified.

PART 2 -- PRODUCTS

2.1 SANITARY WASTE, DRAIN, AND VENT PIPING

- A. Cast iron waste, drain, and vent pipe and fittings.
1. Cast iron waste, drain, and vent pipe and fittings shall be used for the following applications:
 - a. Pipe buried in or in contact with earth.
 - b. Sanitary pipe extensions to a distance of approximately 5 feet outside of the building.
 - c. Interior waste and vent piping above grade.
 2. Cast iron Pipe shall be bell and spigot or hubless (plain end or no-hub or hubless).
 3. The material for all pipe and fittings shall be cast iron soil pipe and fittings and shall conform to the requirements of CISPI 301, ASTM A888, or ASTM A74.
 4. Cast iron pipe and fittings shall be made from a minimum of 95 percent post-consumer recycled material.
 5. Joints for hubless pipe and fittings shall conform to the manufacturer’s installation instructions. Couplings for hubless joints shall conform to CISPI 310. Joints for hub and spigot pipe shall be installed with compression gaskets conforming to the requirements of ASTM C564.
- B. Copper Tube, (DWV):

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1. Copper DWV tube sanitary waste, drain and vent pipe may be used for piping above ground, except for urinal drains.
 2. The copper DWV tube shall be drainage type, drawn temper conforming to ASTM B306.
 3. The copper drainage fittings shall be cast copper or wrought copper conforming to ASME B16.23 or ASME B16.29.
 4. The joints shall be lead-free, using a water flushable flux, and conforming to ASTM B32.
- C. Polyvinyl Chloride (PVC)
1. Polyvinyl chloride (PVC) pipe and fittings are permitted where the waste temperature is below 140 degrees F.
 2. PVC piping and fittings shall NOT be used for the following applications:
 - a. Waste collected from steam condensate drains.
 - b. Spaces such as mechanical equipment rooms, kitchens, Sterile Processing Services, sterilizer areas, and areas designated for sleep.
 - c. Vertical waste and soil stacks serving more than two floors.
 - d. Exposed in mechanical equipment rooms.
 - e. Exposed inside of ceiling return plenums.
 3. Polyvinyl chloride sanitary waste, drain, and vent pipe and fittings shall be solid core sewer piping conforming to ASTM D2665, sewer and drain series with ends for solvent cemented joints.
 4. Fittings: PVC fittings shall be solvent welded socket type using solvent cement conforming to ASTM D2564.

2.2 PUMP DISCHARGE PIPING

- A. Galvanized steel pump discharge pipe and fittings:
1. Galvanized steel pipe shall be Schedule 40 weight class conforming to ASTM A53/A53M, with square cut grooved or threaded ends to match joining method.
 2. Fittings shall be Class 125, gray-iron threaded fittings conforming to ASME B16.4.
 3. Unions shall be Class 150 hexagonal-stock body with ball and socket, metal to metal, bronze seating surface, malleable iron conforming to ASME B16.39 with female threaded ends.
 4. Flanges shall be Class 125 cast iron conforming to ASME B16.1.
 - a. Flange gaskets shall be full face, flat nonmetallic, asbestos free conforming to ASME B16.21.
 - b. Flange nuts and bolts shall be carbon steel conforming to ASME B18.2.1.
- B. Copper pump discharge pipe and fittings:
1. Copper tube shall be hard drawn Type L conforming to ASTM B88.
 2. Fittings shall be //cast copper alloy conforming to ASME B16.18 or wrought copper conforming to ASME B16.22// with solder joint ends.
 3. Unions shall be copper alloy, hexagonal stock body with ball and socket, metal to metal seating surface conforming to MSS SP-123 with female solder-joint or threaded ends.
 4. Flanges shall be Class 150, cast copper conforming to ASME B16.24 with solder-joint end.

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- a. Flange gaskets shall be full face, flat nonmetallic, asbestos free conforming to ASME B16.21.
 - b. Flange nuts and bolts shall be carbon steel conforming to ASME B18.2.1.
5. Solder shall be lead-free, water flushable flux conforming to ASTM B32 and ASTM B813.

2.3 EXPOSED WASTE PIPING

- A. Chrome plated brass piping of full iron pipe size shall be used in finished rooms for exposed waste piping connecting fixtures, casework, cabinets, equipment and reagent racks when not concealed by apron including those furnished by the Owner or specified in other sections.
1. The Pipe shall meet ASTM B43, regular weight.
 2. The Fittings shall conform to ASME B16.15.
 3. Nipples shall conform to ASTM B687, Chromium-plated.
 4. Unions shall be brass or bronze with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.
- B. In unfinished Rooms such as mechanical Rooms and Kitchens, Chromeplated brass piping is not required. The pipe materials specified under the paragraph "Sanitary Waste, Drain, and Vent Piping" can be used. The sanitary pipe in unfinished rooms shall be painted as specified in Section 09900 – Painting.

2.4 SPECIALTY PIPE FITTINGS

- A. Transition pipe couplings shall join piping with small differences in outside diameters or different materials. End connections shall be of the same size and compatible with the pipes being joined. The transition coupling shall be elastomeric, sleeve type reducing or transition pattern and include shear and corrosion resistant metal, tension band and tightening mechanism on each end. The transition coupling sleeve coupling shall be of the following material:
1. For cast iron soil pipes, the sleeve material shall be rubber conforming to ASTM C564.
 2. For PVC soil pipes, the sleeve material shall be elastomeric seal or PVC, conforming to ASTM F477 or ASTM D5926.
 3. For dissimilar pipes, the sleeve material shall be PVC conforming to ASTM D5926, or other material compatible with the pipe materials being joined.
- B. The dielectric fittings shall conform to ASSE 1079 with a pressure rating of 125 psig at a minimum temperature of 180 degrees F. The end connection shall be solder joint copper alloy and threaded ferrous.
- C. Dielectric flange insulating kits shall be of non-conducting materials for field assembly of companion flanges with a pressure rating of 150 psig. The gasket shall be neoprene or phenolic. The bolt sleeves shall be phenolic or polyethylene. The washers shall be phenolic with steel backing washers.
- D. The di-electric nipples shall be electroplated steel nipple complying with ASTM F1545 with a pressure rating of 300 psig at 225 degrees F. The end connection shall be male threaded. The lining shall be inert and noncorrosive propylene.

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2.5 CLEANOUTS

- A. Cleanouts shall be the same size as the pipe, up to 4 inches; and not less than 4 inches for larger pipe. Cleanouts shall be easily accessible and shall be gastight and watertight. Minimum clearance of 24 inches shall be provided for clearing a clogged sanitary line.
- B. Floor cleanouts shall be gray iron housing with clamping device and round, secured, scoriated, gray iron cover conforming to ASME A112.36.2M. A gray iron ferrule with hubless, socket, inside calk or spigot connection and counter sunk, taper-thread, brass or bronze closure plug shall be included. The frame and cover material and finish shall be nickel-bronze copper alloy with a square shape. The cleanout shall be vertically adjustable for a minimum of 2 inches. When a waterproof membrane is used in the floor system, clamping collars shall be provided on the cleanouts. Cleanouts shall consist of wye fittings and eighth bends with brass or bronze screw plugs. Cleanouts in the resilient tile floors, quarry tile and ceramic tile floors shall be provided with square top covers recessed for tile insertion. In the carpeted areas, carpet cleanout markers shall be provided. Two-way cleanouts shall be provided where indicated on drawings and at every building exit. The loading classification for cleanouts in sidewalk areas or subject to vehicular traffic shall be heavy duty type.
- C. Cleanouts shall be provided at or near the base of the vertical stacks with the cleanout plug located approximately 24 inches above the floor. If there are no fixtures installed on the lowest floor, the cleanout shall be installed at the base of the stack. The cleanouts shall be extended to the wall access cover. Cleanout shall consist of sanitary tees. Nickel-bronze square frame and stainless steel cover with minimum opening of 6 by 6 inches shall be furnished at each wall cleanout. Where the piping is concealed, a fixture trap or a fixture with integral trap, readily removable without disturbing concealed pipe, shall be accepted as a cleanout equivalent providing the opening to be used as a cleanout opening is the size required.
- D. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/hubless cast iron ferrule. Plain end (hubless) piping in interstitial space or above ceiling may use plain end (hubless) blind plug and clamp.

2.6 FLOOR DRAINS

- A. General Data: floor drain shall comply with ASME A112.6.3. A caulking flange, inside gasket, or hubless connection shall be provided for connection to cast iron pipe, screwed or no hub outlets for connection to steel pipe. The drain connection shall be bottom outlet. A membrane clamp and extensions shall be provided, if required, where installed in connection with waterproof membrane. Puncturing membrane other than for drain opening will not be permitted. Double drainage pattern floor drains shall have integral seepage pan for embedding into floor construction, and weep holes to provide adequate drainage from pan to drain pipe. For drains not installed in connection with a waterproof membrane, a 16-ounce soft copper flashing membrane, 24 inches square or another approved waterproof membrane shall be provided.
- B. FD-1: medium duty (non-traffic) floor drain shall comply with ASME A112.6.3. The floor drain shall be constructed of an epoxy coated cast iron body with medium duty nickel bronze grate, double drainage pattern, clamping device, without sediment bucket but with secondary strainer in bottom for large debris. The grate shall be 6 inches minimum.

- C. FD-2: medium duty (non-traffic) floor drain shall comply with ASME A112.6.3. The floor drain shall have an epoxy coated cast iron body, double drainage pattern, clamping device, light duty nickel bronze adjustable strainer with round or square grate of 150 mm (6 inches) width or diameter minimum for toilet rooms, showers and kitchens.

2.7 TRAPS

- A. Traps shall be provided on all sanitary branch waste connections from fixtures or equipment not provided with traps. Exposed brass shall be polished brass chromium plated with nipple and set screw escutcheons. Concealed traps may be rough cast brass or same material as the piping they are connected to. Slip joints are not permitted on sewer side of trap. Traps shall correspond to fittings on cast iron soil pipe or steel pipe respectively, and size shall be as required by connected service or fixture.

2.8 PRIMER VALVES AND TRAP SEAL PRIMER SYSTEMS

- A. Trap Primer (TP): The trap seal primer valve shall be hydraulic, supply type with a pressure rating of 125 psig and conforming to standard ASSE 1018.
 1. The inlet and outlet connections shall be NPS 1/2 inch
 2. The trap seal primer valve shall be fully automatic with an all brass or bronze body.
 3. The trap seal primer valve shall be activated by a drop in building water pressure, no adjustment required.
 4. The trap seal primer valve shall include a manifold when serving two, three, or four traps.
 5. The manifold shall be omitted when serving only one trap.

2.9 PENETRATION SLEEVES

- A. A sleeve flashing device shall be provided at points where pipes pass through membrane waterproofed floors or walls. The sleeve flashing device shall be manufactured, cast iron fitting with clamping device that forms a sleeve for the pipe floor penetration of the floor membrane. A galvanized steel pipe extension shall be included in the top of the fitting that will extend 2 inches above finished floor and galvanized steel pipe extension in the bottom of the fitting that will extend through the floor slab. A waterproof caulked joint shall be provided at the top hub.

PART 3 -- EXECUTION

3.1 PIPE INSTALLATION

- A. The pipe installation shall comply with the requirements of the International Plumbing Code (IPC) and these specifications.
- B. Branch piping shall be installed for waste from the respective piping systems and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Owner or specified in other Sections.
- C. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.

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- D. All pipe runs shall be laid out to avoid interference with other work.
- E. The piping shall be installed above accessible ceilings where possible.
- F. The piping shall be installed to permit valve servicing or operation.
- G. The piping shall be installed free of sags and bends.
- H. Seismic restraint shall be installed where required by code.
- I. Changes in direction for soil and waste drainage and vent piping shall be made using appropriate branches, bends and long sweep bends. Sanitary tees and short sweep quarter bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Long turn double wye branch and eighth bend fittings shall be used if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Proper size of standard increaser and reducers shall be used if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- J. Buried soil and waste drainage and vent piping shall be laid beginning at the low point of each system. Piping shall be installed true to grades and alignment indicated with unbroken continuity of invert. Hub ends shall be placed upstream. Required gaskets shall be installed according to manufacturer's written instruction for use of lubricants, cements, and other installation requirements.
- K. Cast iron piping shall be installed according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings"
- L. Aboveground copper tubing shall be installed according to Copper Development Association's (CDA) "Copper Tube Handbook".
- M. Aboveground PVC piping shall be installed according to ASTM D2665. Underground PVC piping shall be installed according to ASTM D2321.
- N. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no cost to the Owner.

3.2 JOINT CONSTRUCTION

- A. Hub and spigot, cast iron piping with gasket joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hub and spigot, cast iron piping with calked joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
- C. Hubless or No-hub, cast iron piping shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless piping coupling joints.
- D. For threaded joints, thread pipe with tapered pipe threads according to ASME B1.20.1. The threads shall be cut full and clean using sharp disc cutters. Threaded pipe ends shall be reamed

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to remove burrs and restored to full pipe inside diameter. Pipe fittings and valves shall be joined as follows:

- E. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is required by the pipe service.
- F. Pipe sections with damaged threads shall be replaced with new sections of pipe.
- G. Copper tube and fittings with soldered joints shall be joined according to ASTM B828. A water flushable, lead free flux conforming to ASTM B813 and a lead-free alloy solder conforming to ASTM B32 shall be used.
- H. For PVC piping, solvent cement joints shall be used for joints. All surfaces shall be cleaned and dry prior to applying the primer and solvent cement. Installation practices shall comply with ASTM F402. The joint shall conform to ASTM D2855 and ASTM D2665 appendixes.

3.3 SPECIALTY PIPE FITTINGS

- A. Transition coupling shall be installed at pipe joints with small differences in pipe outside diameters.
- B. Dielectric fittings shall be installed at connections of dissimilar metal piping and tubing.

3.4 PIPE HANGERS, SUPPORTS AND ACCESSORIES

- A. All piping shall be supported according to the International Plumbing Code (IPC), Section 15400 – Common Results for Plumbing, and these specifications. Where conflicts arise between these the code and Section 15400 – Common Results for Plumbing the most restrictive or the requirement that specifies supports with highest loading or shortest spacing shall apply.
- B. Hangers, supports, rods, inserts and accessories used for pipe supports shall be painted according to Section 09900 – Painting. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
- C. Horizontal piping and tubing shall be supported within 12 inches of each fitting or coupling.
- D. Horizontal cast iron piping shall be supported with the following maximum horizontal spacing and minimum hanger rod diameters:
 - 1. NPS 1-1/2 inch to NPS 2 inch: 60 inches with 3/8-inch rod.
 - 2. NPS 3 inch: 60 inches with 1/2-inch rod.
 - 3. NPS 4 inch to NPS 5 inch: 60 inches with 5/8-inch rod.
 - 4. NPS 6 inch to NPS 8 inch: 60 inches with 3/4-inch rod.
 - 5. NPS 10 inch to NPS 12 inch: 60 inch with 7/8 inch rod.
 - 6. The maximum spacing for plastic pipe shall be 4 feet.
- E. Vertical piping and tubing shall be supported at the base, at each floor, and at intervals no greater than 15 feet.

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- F. In addition to the requirements in Section 15400 – Common Results for Plumbing shall have the following characteristics:
 - 1. Solid or split unplated cast iron.
 - 2. All plates shall be provided with set screws.
 - 3. Height adjustable clevis type pipe hangers.
 - 4. Adjustable floor rests and base flanges shall be steel.
 - 5. Hanger rods shall be low carbon steel, fully threaded or threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
 - 6. Riser clamps shall be malleable iron or steel.
 - 7. Rollers shall be cast iron.
 - 8. See Section 15400 – Common Results for Plumbing, for requirements on insulated pipe protective shields at hanger supports.
- G. Miscellaneous materials shall be provided as specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 20 feet for cast iron pipe additional support shall be provided in the center of that span. All necessary auxiliary steel shall be provided to provide that support.
- H. Cast escutcheon with set screw shall be provided at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
- I. Penetrations:
 - 1. Water proofing: At floor penetrations, clearances shall be completely sealed around the pipe and make watertight with sealant as specified in Section 07900 – Joint Fillers, Sealants and Caulking.
- J. Exhaust vents shall be extended separately through roof. Sanitary vents shall not connect to exhaust vents.

3.5 TESTS

- A. Sanitary waste and drain systems shall be tested either in its entirety or in sections.
- B. Waste System tests shall be conducted before trenches are backfilled or fixtures are connected. A water test or air test shall be conducted, as directed.
 - 1. If entire system is tested for a water test, tightly close all openings in pipes except highest opening, and fill system with water to point of overflow. If the waste system is tested in sections, tightly plug each opening except highest opening of section under test, fill each section with water and test with at least a 10-foot head of water. In testing successive sections, test at least upper 10 feet of next preceding section so that each joint or pipe except upper most 10 feet of system has been submitted to a test of at least a 10-foot head of water. Water shall be kept in the system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.
 - 2. For an air test, an air pressure of 5 psig gauge shall be maintained for at least 15 minutes without leakage. A force pump and mercury column gauge shall be used for the air test.
 - 3. After installing all fixtures and equipment, open water supply so that all p-traps can be observed. For 15 minutes of operation, all p-traps shall be inspected for leaks and any leaks found shall be corrected.

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4. Final Tests: Either one of the following tests may be used.
 - a. Smoke Test: After fixtures are permanently connected and traps are filled with water, fill entire drainage and vent systems with smoke under pressure of 1 inch of water with a smoke machine. Chemical smoke is prohibited.
 - b. Peppermint Test: Introduce 2 ounces of peppermint into each line or stack.

-END OF SECTION-

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SECTION 15407

FUEL-FIRED DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section describes the requirements for installing a complete gas fired domestic water heating system ready for operation including water heaters, thermometers, and all necessary accessories, connections, and equipment.
- B. A complete listing of all acronyms and abbreviations are included in Section 15400 – Common Results for Plumbing.

1.2 RELATED WORK

- A. Section 01000 – General Specifications
- B. Section 01300 – Submittal Procedures
- C. Section 03300 – Cast-In-Place Concrete: Concrete and Grout
- D. Section 09900 – Painting: Preparation and finish painting.
- E. Section 15400 – Common Results for Plumbing
- F. Section 15403 – Plumbing Piping Insulation
- G. Section 15404 – Facility Water Distribution Piping: Piping, Fittings, Valves and Gauges.

1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standard Institute (ANSI):
 - 1. Z21.10.1-2013 – Gas Water Heaters - Volume 1, Storage Water Heaters with Input Ratings of 75,000 Btu per hour or less
 - 2. Z21.10.3-2013 – Gas-Fired Water Heaters, Volume III, Storage Water Heaters with Input Ratings Above 75,000 Btu per hour, Circulating and Instantaneous
 - 3. Z21.15B-2013 – Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves
 - 4. Z21.18B-2012 – Gas Appliance Pressure Regulators
 - 5. Z21.20A-2010 (R2012) – Automatic Electrical Controls for Household and Similar Use
 - 6. Z21.21-2012 – Automatic Valves for Gas Appliance
 - 7. Z21.22B-2001 (R2008) – Relief Valves for Hot Water Supply Systems

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8. Z21.66-1996 (R2001) – Automatic Vent Damper Devices for Use With Gas-Fired Appliances
- C. American Society for Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
 1. 90.1-(2013) – Energy Standard for Buildings Except Low-Rise Residential Buildings
- D. American Society of Mechanical Engineers (ASME):
 1. ASME Boiler and Pressure Vessel Code
 - a. BPVC Section IV-2013 – Rules for Construction of Heating Boilers
 - b. BPVC Section VIII-1-2013 – Rules for Construction of Pressure Vessels, Division 1
 - c. Form U-1 – Manufacturer’s Data Report for Pressure Vessels
 2. B1.20.1-2013 – Pipe Threads, General Purpose (Inch)
 3. B16.5-2013 – Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard
 4. B16.24-2011 – Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500
 5. CSD-1-2012 – Controls and Safety Devices for Automatically Fired Boilers
- E. American Society of Sanitary Engineering (ASSE):
 1. 1005-1999 – Performance Requirements for Water Heater Drain Valves, 3/4 inch size
- F. National Electrical Manufacturers Association (NEMA):
 1. ICS 6-2011 – Industrial Control and Systems: Enclosures
- G. National Fire Protection Association (NFPA):
 1. 54-2012 – National Fuel Gas Code
 2. 70-2011 – National Electrical Code (NEC)
- H. NSF International (NSF):
 1. 5-2012 – Water Heaters, Hot Water Supply Boilers, and Heat Recovery Equipment
 2. 61-2012 – Drinking Water System Components – Health Effects
 3. 372-2011 – Drinking Water System Components – Lead Content
- I. Underwriters Laboratories, Inc. (UL):
 1. 429-2013 – Standard for Electrically Operated Valves
 2. 795-2011 – Standard for Commercial-Industrial Gas Heating Equipment

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01300 – Submittal Procedures.
- B. Information and material submitted under this Section shall be marked “SUBMITTED UNDER SECTION 22 34 00 – FUEL-FIRED DOMESTIC WATER HEATERS”, with applicable paragraph identification.

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- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
 - 1. Water Heaters
 - 2. Pressure and Temperature Relief Valves
 - 3. Thermometers
 - 4. Pressure Gauges
 - 5. Vacuum Breakers
 - 6. Expansion Tanks
 - 7. Heat Traps
 - 8. Gas Shut-off Valves
 - 9. Motorized Gas Valves
 - 10. Gas Pressure Regulators
 - 11. Manifold Kits

- D. For each gas fired domestic hot water heater type and size, the following characteristics shall be submitted:
 - 1. Rated Capacities
 - 2. Operating characteristics
 - 3. Electrical characteristics
 - 4. Furnished specialties and accessories
 - 5. A form U-1 or other documentation stating compliance with the ASME Boiler and Pressure Vessel Code.

- E. Shop drawings shall include wiring diagrams for power, signal and control functions.

- F. Submit documentation indicating compliance with applicable requirements of ASHRAE 90.1 or Energy Star for Service Water Heating.

- G. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replaceable parts:
 - 1. Include complete list indicating all components of the systems.
 - 2. Include complete diagrams of the internal wiring for each item of equipment.
 - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.

1.5 QUALITY ASSURANCE

- A. Comply with American Society of Heating, Refrigerating and Air- Conditioning Engineers (ASHRAE) for efficiency performance ASHRAE 90.1, "Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings for commercial water heaters."

- B. Electrical components, devices and accessories shall be listed and labeled as defined in NFPA 70 by a qualified testing agency and marked for intended location and application.

- C. ASME code construction shall be a vessel fabricated in compliance with the ASME BPVC Section VIII-1.

- D. Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

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- E. The domestic water heater shall be certified and labeled by an independent testing agency.

1.6 AS-BUILT DOCUMENTATION

- A. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- B. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them on Auto-Cad version 2017 provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.

1.7 PRODUCTS

1.8 CONDENSING, GAS FIRED, SEMI-INSTANTANEOUS DOMESTIC WATER HEATERS

- A. The gas fired domestic water heater shall comply with ANSI Z21.10.1.
- B. The water heater design shall provide a combustion efficiency of at least 95 percent at operating conditions. Water heater capacities are scheduled on the drawings.
- C. The tank construction shall be 304 stainless steel with 150 psig working pressure rating and an input to storage ratio of 4,000 BTU/hr per gallon or greater.
- D. The tapping (openings) shall be factory fabricated of materials compatible with the tank and in accordance with appropriate ASME standards for piping connection, pressure and temperature relief valve, pressure gauge, thermometer, drain valve, anode rods and controls. The tappings shall be:
 - 1. 2 inch and smaller: Threaded ends according to ASME B1.20.1.
 - 2. 2-1/2 inch and larger: Flanged ends according to ASME B16.5 for steel and stainless steel flanges, and according to ASME B16.24.
- E. The natural gas-fired burner shall include the following:

Metalfiber mesh covering a stainless steel body with spark ignition and flame rectification.

 - 1. All burner material exposed to the combustion zone shall be of stainless steel construction.
 - 2. High temperature limit and low water cutoff devices for safety controls.
 - 3. Automatic ignition in accordance with ANSI Z21.20.

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4. The modulating motor must be linked to both the gas valve body and air valve body with a single linkage. The linkage shall not require any field adjustment.
- F. Water heater shall have an operational setpoint capability of 50 to 190 degrees F and shall maintain the outlet temperature within an accuracy of +/- 4 degrees F during load changes of up to 50 percent rated capacity.
- G. Heater shall operate quietly, less than 55 db(A).
- H. The heat exchanger shall be constructed with 316L stainless steel helical fire tubes, combustion chamber and dished tubesheet, with a two-pass combustion gas flow design.
- I. The drain valve shall be corrosion resistant metal complying with ASSE 1005.
- J. The power vent system shall be interlocked with the burner.
- K. Combination Pressure and Temperature relief Valve: ANSI Z21.22 rated, constructed of all brass or bronze with a self-closing reseating valve.
- L. Water Heater Management: the water heater control system shall incorporate onboard multi-unit sequencing logic that would allow lead-lag functionality & sequencing between multiple water heaters operating in parallel and must have the following capabilities:
 1. Efficiently sequence 2 up to 8 units on the same system to meet the load requirement.
 2. Individual unit feed-forward logic will still be enabled for accurate temperature control equal to individual unit's specification.
 3. Operate one motorized valve per unit as an element of the load sequencing. Valves shall close with decreased load as heaters turn off, minimum of one (quantity must be selectable) must always stay open for recirculation.
 4. Automatically rotate lead/lag amongst the units on the chain and monitor run hours per unit and balance load in an effort to equalize unit run hours.
 5. Automatic bump-less transfer of master function to next unit on the chain in case of designated master unit failure; master/slave status should be shown on the individual unit displays.
 6. Units will default to individual control upon failure of the communications chain.
 7. Night temperature setback.
 8. Designated master control, used to display and adjust key system parameters.
- M. Each water heater shall be supplied with a factory packaged and pre-wired motorized ball valve. This valve shall be controlled by the water heater control system as an element of the onboard water heater management.

1.9 GAS-FIRED, TANKLESS, DOMESTIC-WATER HEATERS

- A. Standard: ANSI Z21.10.3 for gas-fired, instantaneous, domestic-water heaters for indoor application.
- B. The water heater design shall provide a combustion efficiency of at least 95 percent at operating conditions. Water heater capacities are scheduled on the drawings.

- C. Construction: Copper piping or tubing complying with NSF 61 and NSF 372 barrier materials for potable water, without storage capacity.
 - 1. Openings: ASME B1.20.1 pipe thread.
 - 2. Pressure Rating: 150 psig.
 - 3. Heat Exchanger: Copper tubing.
 - 4. Insulation: Comply with ASHRAE 90.1.
 - 5. Jacket: Metal, with enameled finish, or plastic.
 - 6. Burner: For use with tankless, domestic-water heaters and fuel gas.
 - 7. Automatic Ignition: Manufacturer's proprietary system for automatic, gas ignition.
 - 8. Temperature Control: Adjustable thermostat.
- D. Water heater shall have an operational setpoint capability of 50 to 190 degrees F and shall maintain the outlet temperature within an accuracy of +/- 4 degrees F during load changes of up to 50 percent rated capacity.
- E. Support: Bracket for wall mounting.

1.10 DOMESTIC HOT WATER EXPANSION TANKS

- A. A steel pressure rated tank constructed with welded joints and factory installed butyl rubber diaphragm shall be installed as scheduled. The air precharge shall be set to minimum system operating pressure at tank.
- B. The tappings shall be factory fabricated steel, welded to the tank and include ASME B1.20.1 pipe thread.
- C. The interior finish shall comply with NSF 61 and NSF 372 barrier materials for potable water tank linings and the liner shall extend into and through the tank fittings and outlets.
- D. The air charging valve shall be factory installed.

1.11 HEAT TRAPS

- A. Heat traps shall be installed in accordance with ASHRAE 90.1 if not provided integral with the heater.

1.12 COMBINATION TEMPERATURE AND PRESSURE RELIEF VALVES

- A. The combination pressure and temperature relief Valve shall be ANSI Z21.22 and ASME rated and constructed of all brass or bronze with a self-closing reseating valve. The relief valves shall include a relieving capacity greater than the heat input and include a pressure setting less than the water heater's working pressure rating. Sensing element shall extend into storage tank.

PART 2 GAS SHUTOFF VALVES

- A. The gas shutoff valve shall be manually operated with proof of closure conforming to ANSI Z21.15.

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B. GAS PRESSURE REGULATORS

C. The gas pressure regulator shall be appliance type, pressure rating matching inlet gas supply temperature, and conforming to ANSI Z21.18.

2.2 AUTOMATIC GAS VALVES

A. Each water heater shall incorporate dual over-temperature protection with manual reset, in accordance with ASME BPVC Section IV and ASME CSD1. The automatic gas valves shall be appliance type, electrically operated, on-off automatic control, and conforming to ANSI Z21.21.

2.3 THERMOMETERS

A. Thermometers shall be rigid stem or remote sensing, scale or dial type with an aluminum, black metal, stainless steel, or chromium plated brass case. The thermometer shall be back connected, red liquid (alcohol or organic-based) fill, vapor, bi-metal or gas actuated, with 9 inches high scale dial or circular dial 2 to 5 inches in diameter graduated from 40 to 212 degrees F, with two-degree graduations guaranteed accurate within one scale division. The socket shall be separable, double-seat, micrometer-fittings, with extension neck not less than 2-1/2 inches to clear tank or pipe covering. The thermometer shall be suitable for 3/4 inch pipe threads. Thermometers may be console-mounted with sensor installed in separate thermometer well.

2.4 SUPPORTS

- A. Water heater stands shall be factory-fabricated steel for floor mounting capable of supporting water heater and water a minimum of 18 inches above the floor.
- B. Wall brackets for wall mounted heaters shall be factory-fabricated steel capable of supporting water heater and water.

A. MANIFOLD KITS

2.5 For multiple water heater installation, provide factory-fabricated copper manifold kits to include ball-type shutoff valves to isolate each water heater and balancing valves to provide balanced flow through each water heater.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. The water heaters shall be installed on concrete bases unless elevated above the floor. Refer to Section 03300 – Cast-In-Place Concrete and Section 15400 – Common Results for Plumbing.
- B. The water heaters shall be installed level and plumb and securely anchored.
- C. The water heaters shall be installed and connected in accordance with manufacturer’s written instructions with manufacturer’s recommended clearances.

- D. All pressure and temperature relief valves discharge shall be piped to a nearby floor drains with air gap or break.
- E. Thermometers shall be installed on the water heater inlet and outlet piping and shall be positioned such that they can be read by an operator or staff standing on floor or walkway.
- F. Vent piping from gas-train pressure regulators and valves shall be piped to the outside of building and shall conform to NFPA 54.
- G. The thermostatic control shall be set for a minimum setting of 140 degrees F for storage heaters and regulated to a maximum discharge temperature of 130 degrees F for distribution to personnel.
- H. Shutoff valves shall be installed on the domestic water supply piping to the water heater and on the domestic hot water outlet piping.
- I. All manufacturer's required clearances shall be maintained.
- J. A combination temperature and pressure relief valve shall be installed at the top portion of the storage tank in accordance with manufacturer's recommendations. The sensing element shall extend into the tank. The relief valve outlet drain piping shall discharge by positive air gap or break into a floor drain.
- K. Piping type heat traps shall be installed on the inlet and outlet piping of the domestic water heater storage tanks, unless provided integrally with the tanks.
- L. Water heater drain piping shall be installed as indirect waste to spill by positive air gap into open drains or over floor drains. Hose end drain valves shall be installed at low points in water piping for gas fueled domestic hot water heaters without integral drains.
- M. The type B galvanized or stainless steel combustion vent shall be installed and sized according to the water heaters recommendations and extended through the roof or wall as allows by the local fuel gas code or NFPA 54. Install vents for condensing heaters in accordance with manufacturer's recommendations.
- N. Dielectric unions shall be provided if there are dissimilar metals between the water heater connections and the attached piping.
- O. Provide vacuum breakers per ANSI Z21.22 on the inlet pipe if the water heater is bottom fed.
- P. If an installation is unsatisfactory to the Owner's Representative, the Contractor shall correct the installation at no cost to the Owner.

3.2 LEAKAGE TEST

- A. Before piping connections are made, the water heaters shall be tested at a hydrostatic pressure of 200 psig and 240 psig for a unit with a MAWP of 160 psig. If any leakage is found on the water heater, the water heater shall be replaced with a new unit at no additional cost to the Owner.

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3.3 PERFORMANCE TEST

- A. All of the remote water outlets shall be tested to ensure a minimum of 110 degrees F and a maximum of 120 degrees F water flow at all times.

3.4 STARTUP AND TESTING

- A. As recommended by product manufacturer and listed standards and under actual or simulated operating conditions, tests shall be conducted to prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with each integrated system.
- B. The tests shall include system capacity, control function, and alarm functions.
- C. When any defects are detected, correct defects and repeat test at no additional costs to the Owner.

3.5 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for four hours to instruct Owner's Personnel in operation and maintenance of the system.

-END OF SECTION-

SECTION 15500

BASIC HVAC REQUIREMENTS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish all labor, equipment and material for the complete installation of the heating, ventilation, air conditioning, piping, etc. as indicated on the drawings and specified herein.
- B. Air conditioning systems shall be furnished and installed to operate as a system. The Contractor shall coordinate all requirements between manufacturers to insure unit responsibility and compatibility of the systems.

1.2 SUBMITTALS

- A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work or other mechanical and air conditioning work required, all in accordance with the requirements of Section 01300, Submittals.
- B. Data to be submitted shall include but not be limited to:
 - 1. Catalog data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various parts and accessories. The illustrations shall be in sufficient detail to serve as a guide for assembly and disassembly.
 - 2. Complete assembly, and installation drawings with clearly marked dimensions. This information shall be in sufficient detail to serve as a guide for assembly and disassembly and for ordering parts.
 - 3. Weight of all component parts and assembled weight.
 - 4. Sample data sheet of equipment nameplate(s) including information contained thereon.
 - 5. Electrical characteristics, wiring, diagrams, etc.
 - 6. Insulation materials, coating, jackets, detail density, thermal conductivity and thickness of all insulation materials to be furnished.
 - 7. Details of special fasteners and accessories.
 - 8. Type of adhesives, binders, joint cement, mastics.
 - 9. Proposed insulation procedures and installation methods.
 - 10. Spare parts list
 - 11. Special tools list
- C. The Contractor shall obtain from the manufacturer and submit to the engineer copies of the results of all certified shop tests.
- D. The Contractor shall obtain from the manufacturer and submit to the engineer copies of certified letters of compliance in accordance with the Specifications.

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1.3 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall submit operation and maintenance manual in accordance with the procedures and requirements set forth in the General Conditions and Division 1.
- B. Operation and Maintenance Manuals shall be submitted for all equipment.

1.4 MANUFACTURER'S INSTRUCTIONS

- A. Installation of all equipment shall be in accordance with manufacturer's data.
- B. All changes from the installation procedures in manufacturers' data shall be submitted for approval in accordance with the requirements for shop drawings.
- C. Keep all manufacturers' data provided in a secure manner at the job site at all times. Catalog and index this data for convenient reference.
- D. Manufacturers' data shall be available for the information of the Owner, Engineer, and the use of other trades.
- E. Turn over all data to the Owner through the Owner's representative at completion of the Work and final testing.
- F. Furnish Owner, indexed and bound in loose leaf binders, three (3) complete sets of Operating and Maintenance Instructions and pertinent manufacturers' literature and information on all of the apparatus and equipment under this Division of the Specifications.
- G. Submit all instruction books and manuals in accordance with Division 1.

1.5 CODES, PERMITS AND STANDARDS

- A. The Contractor shall obtain and pay for all permits and shall comply with all laws and codes that apply to the Work.
- B. The Contractor shall be responsible for all added expense due to his choice of equipment, materials or construction methods.
- C. All work and materials shall be in full accordance with the latest State rules and regulations or publications including those of the State Fire Marshall, the Uniform Plumbing Code, and all local codes. Nothing in the Plans and/or Specifications shall be construed to permit work not conforming to the above codes, rules and regulations.
- D. All equipment, materials and installations shall conform to the requirements of the most recent edition with latest revisions, supplements and amendments of the following, as applicable:
 - 1. Air Conditioning and Refrigeration Institute (ARI)
 - 2. Air Diffusion Council (ADC)
 - 3. Air Moving and Conditioning Association (AMCA)
 - 4. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE)
 - 5. American National Standards Institute (ANSI)

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6. American Society for Testing and Materials (ASTM)
7. American Society of Mechanical Engineers (ASME)
8. Factory Mutual (FM)
9. National Electric Code (NEC)
10. NFPA 90A Air Conditioning and Ventilation Systems
11. Occupational Safety and Health Standards (OSHA)
12. Sheet Metal & Air Conditioning Contractors National Association (SMACNA)
13. Standard Building Code 1985 edition
14. Standard Mechanical Code 1985 edition
15. Standard Plumbing Code 1985 edition
16. State and local codes, ordinances and statutes
17. Underwriters Laboratories (UL)

E. Others as designated in the specifications.

1.6 QUALITY ASSURANCE

- A. All material and equipment shall be the latest design, new, undeteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such material and equipment.
- B. When two or more units of the same class of material or equipment are required, they shall be products of a single manufacturer.
- C. All work shall be performed in a neat and workmanlike manner by workers skilled in their respective trades, and all materials and equipment shall be installed as recommended by the manufacturers and in accordance with specified codes and standards.
- D. Touch up and/or repaint to match original finishes all factory finished or painted equipment and materials which are scratched or marred during shipment or installation.

1.7 IDENTIFICATION MARKERS

- A. Provide manufacturer's standard laminated plastic, color coded duct markers. Conform to the following color codes:
 1. Yellow/Green: Supply air
 2. Blue: Exhaust, outside, return and mixed air
 3. Nomenclature: Include the following:
 - a. Direction of air flow.
 - b. Duct service (supply, return, exhaust, etc.)

1.8 GASKETS AND CONNECTORS

- A. Provide new gaskets wherever gasketed mating equipment items or pipe connections have been dismantled. Gaskets shall be in accordance with manufacturer's recommendations.
- B. Replace all assembly bolts, studs, nuts and fasteners of any kind which are bent, flattened, corroded or have their threads, heads or slots damaged.

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- C. Furnish all bolts, studs, nuts and fasteners for make up of all connections to equipment and replace any of these items damaged in storage, shipment or moving.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. Each item of equipment shall be furnished and installed complete with all supports, mounting frames, duct work, piping, louvers, panels, grilles, electric drive units and controls, mechanical equipment, electrical work, insulation and appurtenances ready for operation.
- B. All equipment and appurtenances shall be anchored or connected to supporting members as specified or as indicated on the Plans.
- C. All mechanisms or parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection. Individual parts furnished which are alike in all units shall be alike in workmanship, design, and materials and shall be interchangeable. All equipment shall be of the manufacturer's top line, industrial commercial grade.
- D. The Contractor shall ascertain that all chassis, shafts, and openings are correctly located, otherwise he shall cut all new openings required at his own expense. Cutting of new openings shall be coordinated with other trades. Proposed new cutting shall be submitted to the Engineer for review and acceptance prior to cutting.
- E. The Plans shall be taken as diagrammatic. The Contractor shall check the Structural Plans and sections for detail dimensions and clearances. Sizes of ducts and their locations are indicated, but not every offset, fitting, or structural obstruction is shown.
- F. Alignment of ducts may be varied where necessary to account for slight architectural changes or to avoid conflict with the Work of other trades without additional expense to the Owner.
- G. All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided, unless specifically noted otherwise. Equipment shall be supported on spring type vibration isolators.

- END OF SECTION -

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SECTION 15584

CUSTOM AIR HANDLING UNITS

PART 1 -- GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.
- C. Control Panels and Electrical wiring shall conform to the requirements of Division 16, Electrical and Division 17, Instrumentation. Provide a clear plastic NEMA rated, gasketed hinged door to encompass all non NEMA rated front of panel instruments.

1.2 SUMMARY

- A. The Contractor shall furnish all labor, equipment and material for the complete installation of the heating, ventilation, air conditioning system as indicated on the Drawings and specified herein.
- B. Air conditioning systems shall be furnished and installed to operate as a system. The Contractor shall coordinate all requirements between manufacturers to insure unit responsibility and compatibility of the systems.
- C. Work Included Under Other Sections:
- D. 480V, 3-phase power wiring and conduit under Division 16, Electrical.
- E. Motor starters under Division 16, Electrical, unless factory mounted and wired by equipment manufacturer.
- F. 120V, 1-phase wiring and conduit to Control Panels under Division 16, Electrical.

1.3 SUBMITTALS

- A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work or other mechanical and air conditioning work required, all in accordance with the requirements of Section 01300, Submittals.
- B. Data to be submitted shall include but not be limited to:
- C. Catalog data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various parts and accessories. The illustrations shall be in sufficient detail to serve as a guide for assembly and disassembly.

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- D. Complete assembly and installation drawings with clearly marked dimensions. This information shall be in sufficient detail to serve as a guide for assembly and disassembly and for ordering parts.
- E. Weight of all component parts and assembled weight.
- F. Electrical characteristics, wiring, diagrams, etc.
- G. Sample data sheet of equipment nameplate(s) including information contained thereon.
- H. Insulation materials, coating, jackets, detail density, thermal conductivity and thickness of all insulation materials to be furnished.
- I. Details of special fasteners and accessories.
- J. Type of adhesives, binders, joint cement, mastics.
- K. Proposed insulation procedures and installation methods.
- L. Spare parts list.
- M. Special tools list.
- N. Control Panels:
 - 1. Panel layout drawings indicating dimensions and device layout for panel mounted devices, sub-panel mounted devices and internal components.
 - 2. Wiring schematics indicating factory installed wiring as well as field installed interconnection wiring between control panels, and remote mounted equipment.
 - 3. Catalog data for all control panel components including but not limited to enclosures, controllers, starters, pilot lights, selector switches, pushbuttons, etc.
- O. The Contractor shall obtain from the manufacturer and submit to the Engineer copies of the results of all certified shop tests.
- P. The Contractor shall obtain from the manufacturer and submit to the Engineer copies of certified letters of compliance in accordance with the Specifications.
- Q. The Contractor shall submit operation and maintenance manual in accordance with the procedures and requirements set forth in the General Conditions and Division 1. Operation and Maintenance Manuals shall be submitted for all equipment.
- R. Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists and wiring diagrams.
- S. In addition to a full set of manuals with closeout documentation, each unit shall ship with its own manual in a watertight enclosure.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to the Project Site under the provisions of Division 1.
- B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.
- D. Protect openings in casing and seal them with plastic wrap to keep dirt and debris. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.5 EXTRA MATERIALS

- A. Provide one additional set of specified fan belts, sheaves, and filters for each unit, packaged for storage. Tag products to identify associated unit.

1.6 SCHEDULES ON DRAWINGS

- A. In general, all capacities of equipment and motor and starter characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. The capacities shown are minimum capacities. Variations in capacities of the scheduled equipment supplied under this Contract will be permitted only with the written direction of the Engineer.
- B. Motors and wheel diameters shown on the schedules are the minimum. If a larger wheel diameter or horsepower is required, it shall be so quoted and noted.

1.7 MANUFACTURER'S INSTRUCTIONS

- A. Installation of all equipment shall be in accordance with manufacturer's data.
- B. All changes from the installation procedures in manufacturers' data shall be submitted for approval in accordance with the requirements for shop drawings.
- C. Keep all manufacturers' data provided in a secure manner at the job site at all times. Catalog and index this data for convenient reference.
- D. Manufacturers' data shall be available for the information of the Owner, Engineer, and the use of other trades.
- E. Turn over all data to the Owner through the Owner's representative at completion of the Work and final testing.
- F. Submit all instruction books and manuals in accordance with Division 1.

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1.8 CODES, PERMITS AND STANDARDS

- A. The Contractor shall obtain and pay for all permits (unless specifically excluded under Division 1 requirements) and shall comply with all laws and codes that apply to the Work.
- B. The Contractor shall be responsible for all added expense due to his choice of equipment, materials or construction methods.
- C. All work and materials shall be in full accordance with the latest State rules and regulations or publications including those of the State Fire Marshall, the International Mechanical and Energy Codes, and all local codes. Nothing in the Plans and/or Specifications shall be construed to permit work not conforming to the above codes, rules and regulations.
- D. All equipment, materials and installations shall conform to the requirements of the most recent edition with latest revisions, supplements and amendments of the following, as applicable:
- E. Air Conditioning and Refrigeration Institute (ARI)
- F. Air Diffusion Council (ADC)
- G. Air Moving and Conditioning Association (AMCA)
- H. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE)
- I. American National Standards Institute (ANSI)
- J. American Society for Testing and Materials (ASTM)
- K. American Society of Mechanical Engineers (ASME)
- L. Factory Mutual (FM)
- M. National Electric Code (NEC)
- N. NFPA 90A Air Conditioning and Ventilation Systems 2009 edition
- O. NFPA 820 Standard for Fire Protection in Wastewater Treatment and Collection Facilities 2008 edition
- P. Occupational Safety and Health Standards (OSHA)
- Q. Sheet Metal & Air Conditioning Contractors National Association (SMACNA)
- R. State and local codes, ordinances and statutes
- S. Underwriters Laboratories (UL)
- T. Others as designated elsewhere in the specifications.

1.9 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum five (5) years documented experience, who issues complete catalog data on total product.
- B. All material and equipment shall be the latest design, new, not deteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such material and equipment.
- C. When two or more units of the same class of material or equipment are required, they shall be products of a single manufacturer.
- D. All work shall be performed in a neat and workmanlike manner by workers skilled in their respective trades, and all materials and equipment shall be installed as recommended by the manufacturers and in accordance with specified codes and standards.
- E. Touch up and/or repaint to match original finishes on all factory finished or painted equipment and materials which are scratched or marred during shipment or installation.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. Each item of equipment shall be furnished and installed complete with all supports, mounting frames, roof curbs (when applicable) duct work, piping, louvers, panels, grilles, electric drive units and controls, mechanical equipment, electrical work, insulation and appurtenances ready for operation.
- B. All equipment and appurtenances shall be anchored or connected to supporting members as specified or as indicated on the Plans.
- C. All mechanisms or parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection. Individual parts furnished which are alike in all units shall be alike in workmanship, design, and materials and shall be interchangeable. All equipment shall be of the manufacturer's top line, industrial commercial grade.
- D. The Contractor shall ascertain that all chassis, shafts, and openings are correctly located otherwise he shall cut all new openings required at his own expense. Cutting of new openings shall be coordinated with other trades. Proposed new cutting shall be submitted to the Engineer for review and acceptance prior to cutting.
- E. The Plans shall be taken as diagrammatic. The Contractor shall check the Structural drawing information for detail dimensions and clearances. Sizes of ducts and their locations are indicated, but not every offset, fitting, or structural obstruction is shown.
- F. Alignment of ducts may be varied where necessary to account for slight architectural changes or to avoid conflict with the Work of other trades without additional expense to the Owner.

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- G. All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided, unless specifically noted otherwise. Equipment shall be supported on spring type vibration isolators.

2.2 MANUFACTURERS

- A. Provide custom air handling unit(s) manufactured by one of the following:
 - 1. Innovent Air Handling Equipment
 - 2. Haakon Industries
 - 3. MAFNA
 - 4. Or approved equal
- B. Custom air handling units shall conform to the requirements of this Specification, shall have the performance as listed in the equipment schedule and information indicated on the Contract Drawings, the component order, and dimensions as indicated on the Contract Drawings.
- C. The units shall be factory assembled on an integral base frame, wired, and tested for all operating functions before shipping.
- D. The unit shall be approved for outdoor operation in designated ASHRAE design temperature location.
- E. The unit shall bear certification label from ETL or UL and shall certify entire unit assembly as a system.

2.3 UNIT CONSTRUCTION

- A. The casing shall be able to withstand up to 1.5 times the design static pressure at the fan zero air flow with no more than 0.005 inch deflection per inch of panel span.
- B. Unit base shall be fabricated from C-channels with all joints fully welded. Base shall be 316L-stainless steel.
- C. Exterior walls, roof, down turn plenum and floor shall be 18-gauge Type 316-stainless steel.
- D. Double wall construction insulation and interior metal liner: Casing walls, roof, down turn plenum and floor shall be insulated with 2-inch thick, 3.0 lbs/cubic foot neoprene coated fiber glass or filled foam (R 8.7) insulation with vapor barrier and provided with 22-gauge Type 316 stainless steel inner liner.
- E. Floor wearing surface shall have a 2-inch turned up lip around the entire perimeter. All seams in the floor wearing surface shall be continuously welded. All opening in the floor shall be framed by a collar which extends 2-inches above the wearing surface. Floor sheets shall be welded to all perimeter and intermediate base frame members. Floor wearing surface shall be 18-gauge Type 316L stainless steel.
- F. Unit shall be designed for 4- or 6-point lift.
- G. Provide access doors as required for access to all internal components and controls requiring maintenance or service. Access doors shall be insulated. Doors shall be double pan

construction with fully-welded corners and all pan joints continuously sealed with a butyl rubber sealant. Doors shall be mounted such that doors in negatively pressurized sections shall open out of the unit and doors for positive pressure sections shall open into the unit to prevent doors from popping open as soon as they are unlatched. Door frame shall be fabricated from brake-formed angles of same material required for unit wall casing construction. Frame shall be fitted with a continuous neoprene bulb gasket. Door thickness shall be 2-inches. Each door shall have full length Type 316 stainless steel hinges. Hinges shall be welded or bolted to the door frame and the door pan. Each door shall have two chrome-plated metallic handles. Handles shall be operable from either side of the door. Doors exposed to weather shall be fitted with tiebacks and drip guards above the top of the door and on the bottom of the door for in-swinging doors.

1. Each access door shall include one 12-inch diameter or 10-inch square dual pane tempered glass viewing window.
- H. All units shall be furnished in modular construction. The equipment schedule indicates minimum dimensions for the path of ingress of the AHU sections. The CONTRACTOR is responsible for field verifying that the AHU sections will fit in their proposed path of ingress. The unit construction shall be of modular construction and shipped to the site for field assembly. The unit shall come with full assembly instructions for assembling the unit pieces including, wiring diagrams, assembly details, section numbers and arrangements, bolting torques and patterns, etc.
- I. Each section of the AHU cabinet shall be provided with a unit drain. The cabinet floor shall be sloped to the drain point. The drain shall be capped on the exterior of the unit and is intended for washdown only. A trap is not required.

2.4 FAN ASSEMBLY

- A. Original source for fans shall be the manufacturing facilities of one of the following available manufacturers:
1. Twin City Fan.
 2. New York Blower.
 3. Greenheck.
 4. Or equal.
- B. Fans shall be single assembly type arranged for even air distribution over the heat exchanger.
- C. Fan wheels shall be backward-inclined aluminum (see coating specified below) and mounted on a type 316 stainless steel shaft selected for operation a minimum of 20% below the first critical RPM.
- D. Bearings shall be the grease lubricated pillow block type supported on a rigid structural epoxy coated steel frame. Fan bearings shall be rated for 80,000 hours AFBMA L-10 life at maximum fan RPM operating conditions.
- E. Motors shall be mounted on an adjustable base. Motors 7.5 HP and smaller shall be equipped with a variable pitch V belt drive when not supplied with a VFD.

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- F. Fan motor assembly shall be provided with internal vibration isolation and a neoprene coated flexible connector between the fan outlet and fan section wall. Vibration isolators shall be coated with epoxy coating system specified below.
- G. Motors shall be TEFC premium efficiency (except motors in Classified areas shall be explosion proof rated for Class 1 Division 1), 460 Volt, 3-phase, 60 Hz. and have a 1.15 service factor.

2.5 INLET HOOD AND LOUVER (OUTDOOR UNITS)

- A. Inlet hood and louver shall be provided for weather protection for openings on the unit exterior.
- B. Material shall be same as exterior liner.
- C. Provide Type 304 stainless steel bird screen on the louver.

2.6 FILTER SECTION

- A. Filter sections shall have filter racks and block-offs fabricated from Type 316 stainless steel as required to prevent air bypass around filters. (Note to Specifier: Consider metallic filters or water resistance filters due to snow/rain.)
- B. Units shall be supplied with two-inch angled filters unless indicated otherwise on the equipment schedules or AHU detail drawings.
- C. Filters shall be arranged in a V-bank configuration to minimize air pressure drop. Filters shall be deep pleated 2-inch filters with a MERV 11 rating (60-65% ASHRAE 52.1) unless indicated otherwise in the equipment schedule.
- D. Provide photohelic pressure switch with local indicating gauge. Gauge shall be ranged for 0-2" WC unless required otherwise by the provided filters. Switch shall use type 316 stainless steel instrument tubing for air sensing lines. Switch shall Dwyer Series A3000 with low temperature option.

2.7 INTERIOR LIGHTING AND CONVENIENCE RECEPTACLES

- A. Washdown proof lights shall be provided in all units. Lights shall be cast aluminum base style with glass globe and cast aluminum guard and 60 watt, or equivalent light output, lamp. Provide one light in each section where an access door is provided for maintenance or includes either a fan, damper, filter rack, coil, or wheel. A switch shall control the lights in each compartment (one switch per light). All wiring shall run neatly installed in rigid aluminum conduit run parallel and/or perpendicular to interior walls and terminate in the AHU electrical enclosure in terminal strips. The lighting circuits shall be 115 VAC and powered from a separate 120V circuit provided by Division 16. Wiring and conduit shall conform to Section 16123 – Wire and Cable.

2.8 DAMPERS

- A. Unit mounted dampers shall be provided in accordance with the applicable damper section in Section 15600 – Ductwork Accessories based on the material and type of damper being furnished. Damper materials shall match the interior unit casing material unless otherwise specified. Dampers for outside air intake shall be thermally insulated double walled type damper blades with a minimum R Value of 4.9.
- B. Unless otherwise specified, all units shall be equipped with motorized dampers for all duct connections or outside air intakes. Dampers shall be integral to the unit.
- C. Damper actuator's power and end switches shall be wired to a terminal strip located in the AHU electrical enclosure.
- D. Damper actuators shall be in accordance with Paragraph 2.12(B) of this Specification.

2.9 CORROSION COATING SYSTEM

- A. Provide a corrosion coating system on all unit component surfaces except stainless steel surfaces. The coating shall be suitable for use for air typically found at a Wastewater Treatment Facility which shall include warm moist air containing 5 ppm hydrogen sulfide. Equipment located outside shall also be suitable to exposure to brackish marine air.
- B. Coating shall be a dipped or electrostatically spray applied baked enamel coating system to ensure complete coverage. Coating system shall be Heresite P-413C, Blygold, Incralac, or equal. For equipment installed outdoors, if the coating system is not suitable for UV exposure, a UV resistant topcoat shall be applied.

2.10 FACTORY SUPPLIED CONTROLS/WIRING

- A. Provide a system of motor control, including all necessary terminal blocks; motor contactors, variable frequency drives, motor overload protection, grounding lugs, control transformers, auxiliary contactors and terminals for the connection of external control devices or relay
- B. Electrical enclosures shall be ventilated or cooled to dissipate heat generated in the enclosure by VFDs, motor contactors, and other miscellaneous electrical devices. The method of cooling shall not negate the enclosure NEMA rating.
- C. Single point power connection.
- D. The hot water coils shall be protected with a freezestat. The freezestat shall be located on the discharge of the hot water coil and shall be installed per the freezestat manufacturer's installation instructions. On a heating system failure, this device will shut down the fan and close all AHU dampers. This device shall require a manual reset to restart the unit.
- E. The unit shall be supplied with a flow measuring station. The station shall be capable of measuring the airflow through the unit. The airflow signal shall be run to terminal blocks in the unit mounted electrical enclosure. The signal shall be a 0-10V DC signal.

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- F. Factory-wired fuse-protected control transformer, connection for power supply and field-wired unit to any remote control panels.
- G. All signals coming to or leaving the local control panel shall be in terminal blocks. External wires shall not terminate directly in relays, buttons, switches, or other control panel devices.
- H. All unit mounted devices shall be powered from the single point power connection of the unit. The AHU manufacturer shall provide any required power supplies or transformers.
- I. Devices and instruments powered from the AHU control panel shall be individually protected from short circuits and overloads by fused terminal blocks or breakers.
- J. All unit mounted device signals shall be wired back to an AHU electrical enclosure and terminated in terminal blocks for connection to the HVAC Control System indicated in Section 15950 – HVAC Controls. Devices include but are not limited to sensor readings, end switch signals, actuator feedback position, device status, etc. All analog signals shall be 0-10V DC signals.
- K. The AHU VFDs shall be capable of communicating with the HVAC Control System furnished by the Contractor through an ethernet connection. The ethernet connection shall provide communication for signals between the HVAC Control System and VFD such as alarms, status information, speed feedback, etc. The required speed command signal from the HVAC Control System to the VFD shall be a hard-wired analog signal. Use of the ethernet connection or other serial communication for the speed command is prohibited.
- L. Refer to Section 15950 – HVAC Controls for related requirements and overall project HVAC Control System requirements.
- M. Unit Mounted Control Panel (All Units):
 - 1. Construction: Unit-mounted, NEMA 4X, 316 stainless steel with engraved plastic cover, and the following lights and switches:
 - a. Dirty-filter indicating light.
 - b. Freezestat Alarm indicating light.
- N. All factory and field installed cable shall be run in rigid aluminum conduit. Conduits shall conform to Section 16123 – Wire and Cable.

2.11 CONTROLS

- A. Control Panels:
 - 1. Provide integral control panels completely factory pre-wired with Variable Frequency Drives (VFDs) and overloads for air handling blower motor, control transformer, high limit, air flow station, freezestat, terminal block, necessary relays, and disconnect switches. Panels shall conform to the requirements of Division 16.
 - 2. All unit mounted sensors and electrical devices shall be wired to terminal blocks for control by the HVAC Control System. The HVAC Control System shall be provided and wired by the CONTRACTOR.
 - 3. Control devices such as relays, indicating lights, pushbuttons, and sensors shall comply with requirements in Section 15950 – HVAC Controls.

4. Damper actuators shall be controlled by relays provided by the AHU manufacturer. Each damper shall be controlled by a separate relay. The damper actuator shall be powered by the single point power connection to the unit. The AHU manufacturer shall furnish any transformers or power supplies required. The damper relay coil contacts shall be wired to terminal blocks for control by the HVAC Control System. The relay coil voltage shall be coordinated with the HVAC Control System supplier. Relays shall be socket type ice-cube relays.
5. In addition to wiring the alarm to terminals, the following indicating lights shall also be provided in the AHU electrical enclosure
 - a. Freeze stat
 - b. Dirty filter
 - c. The control panel shall be completely factory assembled and wired, including cabinet, components, wiring, terminal strips to facilitate final connections and with nameplates. The AHU Manufacturer shall submit panel drawings and complete panel wiring diagrams for approval prior to fabrication. Panel construction shall conform to NEMA and NEC code requirement
 - d. Provide within panel all auxiliaries including lights, timers, transformers, fuses, breakers, transmitters, as required for controls.
 - e. All indicators and operating control devices are to be flush mounted on door or face of cabinet and labeled with permanent nameplates.

B. Damper Actuators:

1. Type: Electric, direct coupled (over the shaft).
2. Spring return or proportional as indicated in the Sequence of Operations.
3. V-bolt and V-shaped cradle damp shaft attachment.
4. Mechanical spring return mechanism; Proportional (non-spring return) shall have an external manual gear release.
5. Electronic overload or digital rotation sensing circuitry to prevent damage to actuator throughout rotation of actuator.
6. Reversible rotation by changing mounting orientation.
7. Factory mounted electrical cable and conduit fitting for connection to junction box.
8. UL Standard 873.
9. Min. torque 133-in-lb., for control of damper surface up to 35 ft²
10. 120 VAC.
11. Multiple actuators may be required for devices requiring more than 133-in-lb torque, the AHU manufacturer is responsible for determining torque required and providing the applicable quantity of actuators.
12. Damper actuators shall fail close unless indicated otherwise in the equipment schedule.
13. Accessories:
 - a. Angle of rotation limited.
 - b. Damper linkage kit.
 - c. Mounting bracket.
 - d. Open and Close end switches.
 - e. If the actuator is not rated NEMA 4X, an external NEMA 4X enclosure shall be provided
14. Manufacturer:
 - a. Belimo, Series: AF120-S
 - b. Honeywell Series: MS4120A
 - c. Johnson Series: M9220

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d. Or equal.

C. Control Sequence of Operation:

1. The HVAC Control System shall control unit functions such as opening dampers, starting fans, and modulating hot water valves. The HVAC Control System shall be provided by the Automatic Temperature Contractor in accordance with Section 15950 – HVAC Controls.
2. Instruments and electrical devices provided in or by the AHU manufacturer shall be wired to terminal blocks located in the AHU manufacturer’s unit mounted electrical enclosure.
3. The AHU VFD shall receive a 0-10V DC hard wired signal from the HVAC Control System. The AHU VFD shall ramp up and down in response to this signal.
4. The low temperature cutoff switch and the dirty filter pressure switch shall be wired to terminal blocks for use by the HVAC Control System. In addition, the AHU panel shall also activate alarm lights on the AHU mounted control panel. If sufficient contacts are not available in the device for two signals, the AHU manufacturer shall provide relays to split the signal. The relays shall be powered by the 120V cabinet light power connection to the AHU electrical enclosure. Any transformers necessary shall be supplied by the AHU manufacturer.

2.12 NAME PLATES

- A. Black or white laminated phenolic plastic with minimum 3/16-inch-high black engravings if viewing distance is less than 24 inches, 1/2-inch high lettering for distances up to 72-inches, and proportionately larger lettering for greater distances.
- B. Nameplates shall be affixed with weatherproof adhesive.

2.13 GASKETS AND CONNECTORS

- A. Provide new gaskets wherever gasketed mating equipment items or pipe connections have been dismantled. Gaskets shall be in accordance with Manufacturer's recommendations.
- B. Replace all assembly bolts, studs, nuts and fasteners of any kind which are bent, flattened, corroded or have their threads, heads or slots damaged.
- C.
- D. Furnish all bolts, studs, nuts and fasteners for makeup of all connections to equipment and replace any of these items damaged in storage, shipment or moving.

2.14 SPECIAL TOOLS AND SUPPLIES

- A. Furnish all special tools, supplies, and parts necessary to install, disassemble, service, and repair the equipment.
- B. Items shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each item shall be properly identified by a separate number. Those items which are identical for more than one size, shall have the same part number. Items shall be

packed in individual, suitable containers clearly labeled with the part number; name, quantity, and the equipment for which they are intended.

- C. Tools, supplies, and parts shall be delivered at the same time as the equipment to which they pertain. The CONTRACTOR shall properly store and safeguard such items until completion of the work, at which time they shall be delivered to the OWNER.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. All installation shall be in accordance with manufacturer's published recommendations.
- C. All exterior equipment shall be properly secured and anchored to structure.
- D. Install units on vibration isolators, where fans are not internally isolated.
- E. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation of the Owner's representative(s).
- F. Provide the minimum access space for maintenance of individual components such as fans, filters, coils, etc., as scheduled or shown on the Drawings. Arrange these components in a manner that allows for ease of replacement.
- G. Arrange fans and surrounding components in such a way that poor fan performance does not result.

3.2 MANUFACTURER'S SERVICES

- A. Furnish the services of a certified manufacturer's factory trained service personnel to assist in the installation of the equipment, check the installation before it is placed into operation, supervise initial operations and instruct plant operators in the care, operation and maintenance of the equipment. A certificate from the manufacturer relative to these services is required.
- B. Service personnel shall not make less than three (3) visits to the site as necessary to assist in the installation of the equipment, to check the completed installation, to perform the tests, and to instruct plant operators in the proper care, operation and maintenance of the equipment.
- C. Training: In addition to the above requirements, furnish the services of the manufacturer's factory-trained representative to instruct and train plant operators in accordance with the requirements of Division 1 at a time to be specified by the OWNER for a minimum of eight (8) hours on site.

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3.3 CLEANING

- A. Clean dirt and marks and other debris from exterior of equipment weekly.
- B. Remove debris and waste material resulting from installation weekly.

3.4 MANUFACTURERS WARRANTY

- A. All components, parts, and assemblies shall be guaranteed against defects in materials and workmanship for a period of two (2) years. The period of such warranties shall start on the date the particular equipment is placed in use by the Owner with corresponding start-up certification provided by the manufacturer's technical representative as specified herein, provided that the equipment demonstrates satisfactory performance during the thirty day operational period after the equipment startup. If the equipment does not perform satisfactorily during the thirty day operational period, the start of the warranty period will be delayed until the equipment demonstrates proper operation. The Equipment Supplier shall repair or replace without charge to the Owner any part of equipment which is defective or showing undue wear within the guarantee period, or replace the equipment with new equipment if the mechanical performance is unsatisfactory; furnishing all parts, materials, labor, etc., necessary to return the equipment to its specified performance level.

-END OF SECTION-

SECTION 15590
POWER VENTILATORS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. Provide exhaust fans which have been tested and rated in accordance with AMCA standard, and bear AMCA Certified Ratings Seal.
- B. Provide exhaust fans which are listed by UL and have UL label affixed, and which are designed, manufactured, and tested in accordance with UL 705 "Power Ventilators".
- C. Provide motors and electrical accessories complying with NEMA standards.
- D. Exhaust fans shall be standard prefabricated units of the type, size and arrangement indicated on the Drawings. All fans shall be rated and constructed in accordance with the Air Moving and Conditioning Association. Special construction materials, coatings and multi-speed fan motors shall be provided as indicated on the Drawings.
- E. The propellers shall be rigidly constructed, accurately balanced dynamically and statically and free from objectionable vibration or noise.
- F. Fans shall have no overloading characteristics for the horsepower indicated.
- G. V belt drives shall be rated at least 50 percent greater than the rated motor horsepower, and shall have sheaves which can vary the fan speed by 10 percent above or below the rating point. The fan motor shall be mounted on an adjustable heavy steel mounting plate.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 15000 - Basic Mechanical Requirements
- B. Section 15500 - Basic HVAC Requirements.

1.3 SUBMITTALS

- A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work required for all equipment specified in this section in accordance with Section 01300, Submittals. Additional required information shall include: the horsepower, voltage, and rotative speed of motors and the total weight of the equipment plus the approximate weight of the shipped materials. Shop drawings shall also include complete erection, installation, and adjustment instructions and recommendations.

1.4 OPERATION AND MAINTENANCE MANUALS

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- A. The Contractor shall submit complete operation and maintenance manuals in accordance with the procedures and requirements set forth in Section 01300, Submittals.

1.5 MANUFACTURERS

- A. The materials covered by these specifications are intended to be standard equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Contract Drawings and operated per manufacturer's recommendations.

1.6 CONTRACTOR'S RESPONSIBILITY

- A. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of each item of equipment furnished under this Contract and instruct the Owner's operating personnel in its maintenance and operation as outlined in Section 11000, Equipment General Provisions and in Division 1, General Requirements. The services of the manufacturer's representative shall be provided for a period of not less than one-half (1/2) day, for each type of equipment item. All related items shall be furnished by one supplier for system compatibility.
- B. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Engineer's Resident Project Representative on each day he is at the project.
- C. A written report covering the representative's findings and installation approval shall be mailed directly to the Engineer covering all inspection and outlining in detail any deficiencies noted.
- D. The times specified are exclusive of travel time to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

1.7 GENERAL INFORMATION AND DESCRIPTION

- A. All parts of the equipment furnished shall be amply designed and constructed for the maximum stresses occurring during fabrication, erection and continuous operation. All materials shall be new and both workmanship and materials shall be of the very best quality, entirely suitable for the service to which the unit is to be subjected and shall conform to all applicable sections of these specifications. All parts of duplicate equipment shall be interchangeable without modification. Manufacturer's design shall accommodate all the requirements of these specifications.
- B. All anchor bolts, washers, clips, clamps and fasteners of any type shall be constructed of 316 stainless steel. All anchor bolts shall be a minimum of 1/2-inch diameter.

PART 2 -- PRODUCT

2.1 CENTRIFUGAL FANS

- A. Centrifugal fans shall be backwardly inclined, non-overloading blades of aluminum construction. Inlets shall be deep spun for nonturbulent entrance condition.
- B. Fans shall be V-belt or direct driven as indicated on the drawings or as contained herein.
- C. Motors on V-belt units shall be supported on the exterior of the fan casing with bearings encased within the fan tube. All models shall incorporate a 100 percent gasketed panel to permit access to interior direct drive motor. Motors shall be protected and cooled from outside the unit by forced ventilation.
- D. V-belt fans shall be supported by channel supports or brackets for ceiling suspension or wall mounting and provided with extended lubrication fittings and suitable vibration isolation provisions.
- E. Fans shall have internal terminal box mounted on the exterior for ready wiring.
- F. Centrifugal fans shall be as manufactured by Greenheck Fan Corp., Loren Cook Co., Penn Ventilator Co., or equal.

2.2 ADDITIONAL REQUIREMENTS

- A. The following additional requirements shall apply to all fans.
 - 1. Backdraft or motor-operated dampers shall be provided and installed in the openings as indicated on the Contract Drawings.
 - 2. All fans shall be provided with either integral or supplementary vibration or sound-absorbing mountings.
 - 3. Provide removable bird screen, 3/4 inch mesh, 12 gauge aluminum wire.
 - 4. Provide factory wired non-fusible type disconnect switch at motor in fan housing. Provide conduit chase within unit for electrical connection.
 - 5. Unless otherwise shown or specified all roof mounted exhaust fans shall be mounted on a prefabricated roof curb.

2.3 THERMOSTATS

- A. Thermostats for exhaust fans shall be heavy-duty, low voltage type, arranged to open and close the circuit as required by a control point.
- B. Unless otherwise specified or indicated, the range of adjustment shall be 40°F–100°F.
- C. Enclosures for thermostats located in corrosive atmospheres or facilities shall be waterproof NEMA 4X stainless steel type.

2.4 DAMPERS

- A. All exhaust fans shall include a damper. Dampers shall be coordinated to operate and interface with the fan being furnished. All dampers shall be low leakage type. Dampers shall

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be gravity or motor operated where indicated. Motor operators shall be rated for use on 120 VAC and shall be as manufactured by Honeywell, Barber-Coleman, or equal.

- B. Dampers shall have aluminum frames and blades with sealing edges and couplings at both ends with tie-rods. Dampers shall be predrilled to match the fan or louver. Damper finish colors shall be selected by the Engineer from the manufacturer's standard color chart.
- C. Dampers shall be sized to fit the specified openings.

2.5 PREFABRICATED ROOF CURBS

- A. Prefabricated roof curbs shall be installed where indicated on the Drawings or as specified herein. The curbs shall be fabricated of .064 inch sheet aluminum with all joints heliarc welded. Cants and roof flanges shall be an integral part of the curb. The inside of the curb shall be insulated with rigid glass-fiber thermal and acoustical liner of approximately 3-lb. density and 1-1/2 inch minimum thickness with a neoprene or equal coating for protection from erosion. The lining shall conform to NFPA 90A Standards with a flame spread and fuel contributed rating not exceeding 50. Pressure-treated wood nailers shall be provided at the tops of the curbs. The curbs shall be sized to suit equipment. Roof curbs shall be a nominal of 12-inches above the height of the roof.

PART 3 -- EXECUTION

3.1 INSTALLATION OF POWER AND GRAVITY VENTILATORS

- A. Contractor shall install ventilators in accordance with manufacturer's installation instructions and recognized industry practices to insure that ventilators serve their intended function.
- B. Contractor shall coordinate ventilator work with work of walls, and ceilings, as necessary for proper interfacing.
- C. Connect ducts to ventilators in accordance with manufacturer's installation instructions.

3.2 FIELD QUALITY CONTROL

- A. Testing: After installation of ventilators has been completed, test each ventilator to demonstrate proper operation of units at performance requirements specified. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.
- B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

- END OF SECTION -

SECTION 15596
FRP DUCTWORK

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 SUMMARY

- A. The Contractor shall furnish all labor, equipment and material for the complete installation of the exhaust system as indicated on the Drawings and specified herein.
- B. Exhaust equipment and ductwork shall be furnished and installed to operate as a system. The Contractor shall coordinate all requirements between manufacturers to insure responsibility and compatibility of the systems.

1.3 SUBMITTALS

- A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work or other mechanical and air conditioning work required, all in accordance with the requirements of Section 01300, Submittals.
- B. Data to be submitted shall include but not be limited to:
 - 1. The fabricator shall submit for approval all reference standards, fabrication drawings, and any engineering details of the duct design prior to beginning fabrication.
 - 2. The submittal should include all information utilized by the fabricator which describes specifically how their FRP duct and fittings are manufactured. This should be in the form of shop drawings, standards, specifications, other shop instructions and QC records. This should include, but not be limited to:
 - a. Resin Type.
 - b. Types and amounts of filler.
 - c. Corrosion liner description.
 - d. Reinforcement types for hand lay-up or chopped laminates.
 - e. For filament-wound laminates:
 - 1) Helix angle
 - 2) Glass content range
 - 3) Strand yield
 - 4) Strand by inch in the winding band.
 - 5) Ply thickness
 - 6) Amount of chop or unidirectional roving interspersed with winding, if any, and location within laminate.

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- f. For all fabricated parts:
 - 1) Construction type.
 - 2) Laminate thickness.
 - 3) Ply sequences.
 - 4) Glass content range.
 - g. For all secondary overlays (both interior and exterior):
 - 1) Laminate thickness.
 - 2) Ply sequences and widths.
 - h. Construction details for all other special configurations and fabricated parts.
 - 3. FRP round duct sample, minimum size 12 inches diameter by 12 inches long, and a 45° elbow quality of workmanship and glass/resin being quoted. These will be retained for quality comparison on materials shipped to jobsite.
 - 4. Recommended procedure for the protection and handling of materials prior to installation.
 - 5. ISO 9000 based Quality control manual detailing shop QC inspection procedures and documentation, and samples of all shop QC forms utilized in the process.
 - 6. Spare parts list.
 - 7. Special tools list.
- C. The Contractor shall obtain from the manufacturer and submit to the Engineer copies of the results of all certified shop tests.
- D. The Contractor shall obtain from the manufacturer and submit to the Engineer copies of certified letters of compliance in accordance with the Specifications.
- E. Dimensioned duct layout at ¼"=1'-0" scale in AutoCAD showing locations of supports, hangers, anchors, guides and expansion joints, sealed by a Professional Engineer.
- F. The Contractor shall submit operation and maintenance manual in accordance with the procedures and requirements set forth in the General Conditions and Division 1. Operation and Maintenance Manuals shall be submitted for all equipment.
- 1. Include instructions for repair and/or replacement of ducts, and spare parts lists.
 - 2. In addition to a full set of manuals with closeout documentation, material shall ship with its own manual in a watertight enclosure.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to the Project Site under the provisions of Division 1.
- B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.
- D. Protect openings in casing and seal them with plastic wrap to keep dirt and debris. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.5 MANUFACTURER'S INSTRUCTIONS

- A. Installation of all duct systems shall be in accordance with manufacturer's data.
- B. All changes from the installation procedures in manufacturers' data shall be submitted for approval in accordance with the requirements for shop drawings.
- C. Keep all manufacturers' data provided in a secure manner at the job site at all times. Catalog and index this data for convenient reference.
- D. Manufacturers' data shall be available for the information of the Owner, Engineer, and the use of other trades.
- E. Turn over all data to the Owner through the Owner's representative at completion of the Work and final testing.
- F. Submit all instruction books and manuals in accordance with Division 1.

1.6 CODES, PERMITS AND STANDARDS

- A. The Contractor shall obtain and pay for all permits (unless specifically excluded under Division 1 requirements) and shall comply with all laws and codes that apply to the Work.
- B. The Contractor shall be responsible for all added expense due to his choice of equipment, materials or construction methods.
- C. All work and materials shall be in full accordance with the latest State rules and regulations or publications including those of the State Fire Marshall, the Mechanical and Energy Codes, and all local codes. Nothing in the Plans and/or Specifications shall be construed to permit work not conforming to the above codes, rules and regulations.

1.7 REFERENCES

- A. AMCA 500: Test Methods for Louvers, Dampers, and Shutters.
- B. ASTM D 2240: Test Method for Rubber Property-Durometer Hardness.
- C.
- D. ASTM D 2996: Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
- E. ASTM D 3567: Standard Practice for Determining Dimensions of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings
- F. ASTM D 2412: Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
- G. NBS PS 15-69: Custom Contact-Molded Reinforced Polyester Chemical-Resistant Process Equipment.

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- H. ASME RTP-1: Reinforced Thermoset Plastic Corrosion-Resistant Equipment.
- I. ASTM D 2310: Classification for Machine-Made Reinforced Thermosetting Resin Pipe.
- J. ASTM D 2992: Practice for Obtaining Hydrostatic or Pressure Design Basis for “Fiberglass” (Glass-Fiber Reinforced Thermosetting Resin) Pipe and Fittings.
- K. ASTM E 84: Standard Test Method for Surface Burning Characteristics of Building Materials.
- L. SMACNA: Thermosetting FRP Duct and Construction Manual.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum three (3) years documented experience, who issues complete catalog data on total product. Manufacturer shall be able to provide the following information:
 - 1. (2) sample cutouts demonstrating 100 to 110 mils clear liner with no antimony, and filament wound structural laminate. Samples to be a minimum of 8”Ø cut out, and a 12”Ø piece of duct at least 12” long complying with RTP-1 visual level II.
 - 2. Company filament winding history and at least two (2) FRP duct job names with similar type construction, including contact names and phone numbers.
 - 3. (2) copies of the fabricators ISO 9000 based Quality Control Manual, or equal.
 - 4. A letter from an outside testing agency confirming RTP-1 visual level II quality and the quantity and the size of the specimens examined.
 - 5. Certified testing data from an outside testing agency confirming the resin and glass contents of the liner and structural layers separately.
 - 6. Copies of burial calculations for at least 3 sizes of duct between 18” and 48”Ø.
 - 7. Any fabricator unable to provide this information and samples to the engineer 48 hours prior to bid date will not be considered.
- B. All FRP ductwork shall be fabricated and installed by qualified, experienced mechanics, who have a minimum of 5 years’ experience with the lay-up, fabrication and joining of this type of material.
- C. Factory Inspection:
 - 1. Owner and Engineer shall be given access to the FRP Ductwork and all quality control records during fabrication and upon completion for the purpose of verifying compliance to the Contract Documents.
 - 2. The owner shall maintain the right to tour the FRP duct manufacturer’s plant anytime that fabrication is in process prior to final shipment. The owner and engineer may exercise the option, without any advance notice; to tour the plant and inspect all stages of fabrication to ensure that quality control is being maintained.
 - 3. Inspection by owner does not relieve any responsibility of the fabricator to meet the requirements of this specification.
 - 4. Final Inspection - The Engineer and Owner may carry out a final inspection of the equipment prior to shipment. Fabricator shall give the Owner a minimum of 5 days’ advance notice of scheduled ductwork. Prior to final inspection by Owner, the ductwork shall be cleaned of all foreign material, and shall be in a position that allows easy access and viewing.

- D. Lack of compliance with any aspect of the specifications and drawings will be grounds for rejection of the equipment.
- E. Repair of rejected equipment - Repair procedures must be approved by the owner prior to implementation. No more than 5 percent of the surface area of each FRP duct component may be repaired.
- F. The fabricator's inspector (Quality Control Manager) shall provide the Owner with a complete Quality Control report for the job. The report shall be available within 15 days after the final parts are shipped. The fabricator will have available after each shipment, the completed QC sheets for review upon request at any time.

PART 2 PRODUCTS

2.1 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
- B. Fasteners shall be Type 316L stainless steel.
- C. The Plans shall be taken as diagrammatic. The Contractor shall check the Structural Plans and sections for detail dimensions and clearances. Sizes of ducts and their locations are indicated, but not every offset, fitting, or structural obstruction is shown.
- D. Alignment of ducts may be varied where necessary to account for slight architectural changes or to avoid conflict with the Work of other trades without additional expense to the Owner.
- E. All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided, unless specifically noted otherwise.

2.2 FRP DUCT SYSTEM

- A. Product and Manufacturer: Provide product(s) of one of the following:
 - 1. Spunstrand Inc., Wallace ID
 - 2. Harrington Plastics, San Bernardino CA
 - 3. Ershigs Inc., Bellingham WA
 - 4. Perry Fiberglass Products, Avon Lake OH
 - 5. Ameron International
 - 6. Or Approved Equal.
- B. Type: Filament wound rated at design pressures indicated below. Minimum wall thickness shall be in accordance with SMACNA SI at .145 for 2" through 30", S3 at .180 for 32" through 42", S5 at .220 for 48" through 60", and S7 at .260 for 72". Rectangular ductwork thickness shall be as specified in SMACNA, NBS PS 15-69, the drawings and detail sheets.
- C. Grade: Type 1, Grade 2 RTRP, Class E per ASTM D2310 and D2996.

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- D. All ducts shall be designed for not less than 30 inches water column pressure, and 10 inches water column vacuum. The design, applicable construction, and inspections shall be in accordance with SMACNA, and visual inspection criteria in accordance with ASME RTP-1, Table 6, Visual Level II.
- E. A minimum structural safety factor of 4 shall be used in the design of ducting.
- F. Maximum deflection of rectangular ducts under deadload and operating conditions shall not exceed 1 percent of the width of the longest side.
- G. The resin used shall be Ashland Chemical Hetron 992FR, or Derakane 510 depending on availability, selected to meet the exposures and temperatures of the air to be exhausted. Minimum barcol hardness: 36. Fillers other than antimony trioxide added for flame retardancy when required, shall not be allowed, and should not exceed 5% by weight. A thixotropic agent for viscosity control may be used as recommended by the resin manufacturer. No thixotropic agent is to be used in the corrosion liner or on surfaces to be in contact with the corrosive environment. Flame spread rating shall be 25 or less per ASTM E-84. Catalyst shall be DHD9 or High Point 90 per resin manufacture.
- H. Corrosion liner: Inner surface shall contain one ply of 10 ml thick minimum C-glass surfacing veil saturated with vinylester resin. The surface veil shall be overlapped a minimum of 1". Two (2) layers of 1-1/2 oz./sq.ft chopped strand mat shall follow surface veil layers. Corrosion liner is to gel completely before proceeding with structural laminates. In no case shall the interruption exceed 12 hours. Total liner thickness to be 100 mils. No thixotropic agent or fire retardant additive is to be used in the liner resin. Corrosion liner shall contain not less than 20 % or more than 30% glass by weight. Liner shall pass ASME RTP-1 Table 6, level II visual inspection. Total glass content 25 to 30%.
- I. Structural layer shall be filament wound of Hetron 992FR, or Derakane 510 premium grade, vinylester resin and Type E 250 strand yield continuous glass roving. The band width is 2 1/4" using and average of (7) strands per inch. Filament winding cycle thickness to be 0.06" maximum. Glass content 55 to 65 %. Winding angle shall be 65°± 2° for increased vacuum service.
- J. Exterior of all laminates shall contain sufficient resin to insure a relatively smooth surface free from exposed glass fibers or sharp projections. An ultraviolet stabilizer added to the final coat of resin that also incorporates paraffinated wax curing elements. For optional exterior finishes, ductwork located outdoors shall contain an exterior colored surface coat. Color to be selected by owner. Ductwork indoors shall have 2 coats of PPG 42-7 Intumescent paint to provide a class 1 flame and smoke rating. ASTM E-84 Steiner Tunnel test results shall be attached as part of the submittal packet.
- K. Standard lengths shall be in accordance with the manufacturers published product data sheets and approved shop drawings. Wall thickness of the duct furnished shall not at any point be less than specified minimum wall thickness when measured in accordance with ASTM D3567.
- L. Duct stiffness: The duct shall have a minimum pipe stiffness in accordance with ASTM D2412 for the pipe laying conditions as noted for the design conditions.

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2.3 ACCESSORIES

A. Fittings:

1. Radius elbows shall be formed over a removable mold for diameters up to 30"Ø, and fabricated from straight duct for all sizes 42"Ø and larger as follows:
 - a. Bends up to 30° — 1 miter/2 gore
 - b. 31° to 60° bend — 2 miter/3 gore
 - c. 61° to 90° bend — 4 miter/5 gore
2. Turning vanes and splitters shall be provided at all single mitered bends 46° and greater, and similar fittings that are not one-piece smooth radius fittings per SMACNA and ASHRAE standards. Turning vanes shall be filament wound and reinforced with unidirectional glass in lieu of stainless steel. Stainless Steel is not acceptable.
3. Dampers:
 - a. FRP Dampers shall be fabricated with the same materials as the duct. No resin variations will be acceptable. Blade shall be FRP 2 piece molded including blade stiffeners per schedule on drawing. Damper blade shall be offset 5° in closed position to form a normal stop on wall of duct. Axle to be pultruded FRP made with same resin and continuous strand roving. Bearing to be Teflon. O-rings shall be Viton. No metal parts or cut edges in airstream will be allowed.
 - b. Balancing dampers to be Spunstrand Inc. BA series, or Swartwout model 912 with blade stop, axle shaft seals, and locking hand quadrant.
 - c. Isolation dampers to Spunstrand Inc. ZL Series (Zero Leak), Ershigs type "B", or Swartwout model 914 with blade seals, axle shaft seals, and gear operator. Flanges included on all isolation dampers, and on balancing dampers when shown on drawings. Either damper submitted shall have AMCA certified leakage rates, or shall be individually water tested and certified leak free. No other shop-fabricated dampers shall be allowed. See separate specifications for Zero Leak Dampers and cut-sheets.
4. Rectangular Dampers shall be Swartwout 426AF with airfoil blade seals, rated with certified AMCA leakage rates, and shall not exceed 20 cfm per sq/ft.
5. Flanges:
 - a. Flanges shall be one piece integral through 24"Ø and per SMACNA Thermoset Duct construction manual, and supplied undrilled for field drilling and alignment.
 - b. All bolts, nuts and washers shall be 316L stainless steel, and supplied by contractor.
6. Joints:
 - a. Duct joints shall be butt and wrap joint type connections.
 - b. Fittings shall be butt and wrap joint type connections.
 - c. Adhesive material for field joining shall be supplied in rolls and resin containers no larger than five gallons.
 - d. All joints shall be per SMACNA standard, and per attached laminate schedule.

B. Miscellaneous Requirements:

1. Markings on duct and spool pieces shall be in accordance with shop drawings.
2. Fabricators bid shall include as a standard, to wrap all gelcoated or intumescent painted duct and fittings not shipped on pallets in bubble wrap to completely protect

the finishes and can be taped over the ends as a seal. The bubble wrap should then be left on while being unloaded and stored on site. After transportation to final installation point the wrap should finally be removed. Since storage, installation schedules, and transportation around the job site present many challenges, this method is a worthy precaution. While shipping from the factory, the duct can be stacked in layers up to 3 high in diameter up to 24"Ø and 2 high in layers over 30"Ø. Stagger stacking and blocking with the use of bubble wrap will provide full length support along the length of the duct and eliminate bouncing and point wear to the coatings. Fabricators shall fully warranty this method and use only dedicated trucks factory pre-qualified in this method.

2.4 DRAIN PIPE

- A. Provide drains at all low points of duct system.
- B. Poly (Vinyl Chloride) Pipe and Fittings:
 - 1. Pipe: ASTM D1785 and D2466.
 - 2. Weight: Schedule 40.
 - 3. Fittings: ASTM D1785 and D2466.
 - 4. Joints: Chemical weld with manufacturers recommended solvent.

2.5 NAME PLATES

- A. White laminated phenolic plastic with minimum 3/16 inch high black engravings if viewing distance is less than 24 inches, 1/2 inch high lettering for distances up to 72 inches, and proportionately larger lettering for greater distances.
- B. Nameplates shall be affixed with weatherproof adhesive.
- C. Nameplates shall be provided at all control switches, panels, or any other device providing equipment information. Name plates shall be provided on all HVAC equipment matching equipment scheduled identification numbering.
- D. Provide manufacturer's standard laminated plastic, color coded duct markers. Conform to the following color codes:
 - 1. Yellow/Green: Supply air
 - 2. Blue: Exhaust, outside, return and mixed air
 - 3. Nomenclature: Include the following:
 - a. Direction of air flow.
 - b. Duct service (supply, return, exhaust, etc.)

2.6 GASKETS AND CONNECTORS

- A. Provide new gaskets wherever gasketed mating equipment items or pipe connections have been dismantled. Gaskets shall be in accordance with manufacturer's recommendations.
- B. Replace all assembly bolts, studs, nuts and fasteners of any kind which are bent, flattened, corroded or have their threads, heads or slots damaged.

- C. Furnish all bolts, studs, nuts and fasteners for make up of all connections to equipment and replace any of these items damaged in storage, shipment or moving.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. All installation shall be in accordance with manufacturer's published recommendations.
- C. All exterior equipment shall be properly secured and anchored to structure to withstand wind force requirements for the site location.
- D. Do not operate units for any purpose, temporary or permanent, until ductwork is leak tested under observation of the Owner's representative(s).
- E. Provide the minimum access space for maintenance of individual components such as fans, filters, coils, humidifiers, etc., as scheduled or shown on the Drawings. Arrange these components in a manner that allows for ease of replacement.

3.2 CLEANING

- A. Clean dirt and marks and other debris from exterior of equipment weekly.
- B. Remove debris and waste material resulting from installation weekly.

3.3 GUARANTEE

- A. All components, parts, and assemblies shall be guaranteed against defects in materials and workmanship in accordance with the Contract.

-END OF SECTION-

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SECTION 15599
HVAC INSULATION

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install all duct insulation and accessories as shown on the Drawings and in accordance with the Specifications.
- B. Types of mechanical insulation specified in this Section include the following:
 - 1. HVAC Piping System Insulation: Fiberglass
 - 2. Ductwork System Insulation: Fiberglass
 - 3. Refrigerant Suction Piping Flexible Unicellular

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 15290 - Insulation

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. ASTM E84
 - 2. ASTM C533
 - 3. NFPA 255
 - 4. ASTM C921
 - 5. ASTM C1071

1.4 SUBMITTALS

- A. The Contractor shall submit manufacturer's technical product data and installation instructions for each type of mechanical insulation.
- B. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of HVAC insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Installer's Qualifications: Firm with at least 5 years successful installation experience on projects with HVAC insulations similar to that required for this project.

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- C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Specifications, provide products manufactured by one of the following:
 - 1. Armstrong World Industries, Inc.
 - 2. Babcock & Wilcox, Insulating Products Div.
 - 3. CertainTeed Corp.
 - 4. Knauf Fiber Glass GmbH
 - 5. Manville Products Corp.
 - 6. Owens-Corning Fiberglass Corp.
 - 7. Pittsburgh Corning Corp.
 - 8. Rubatex Corp.

2.2 PIPING INSULATION MATERIALS

- A. Fiberglass Piping Insulation: ASTM C 547, Class 1 unless otherwise indicated.
- B. Flexible Unicellular Piping Insulation: ASTM C 543, Type I.
- C. Jackets for Piping Insulation: ASTM C 921, Type I for piping with temperatures below ambient, Type II for piping with temperatures above ambient. Type I may be used for all piping at Installers option.
 - 1. Encase pipe fittings insulation with one-piece premolded PVC fitting covers, fastened as per manufacturer's recommendations.
 - 2. Encase exterior piping insulation with aluminum jacket with weather-proof construction.
- D. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.
- E. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

2.3 DUCTWORK INSULATION MATERIALS

- A. Flexible Fiberglass Ductwork Insulation: ASTM C 553, Type I, Class B-4.
- B. Jackets for Ductwork Insulation: ASTM C 921, Type I for ductwork with temperatures below ambient; Type II for ductwork with temperatures above ambient.
- C. Duct liner ASTM C 1071, Type I, 200.

- D. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.
- E. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

PART 3 3 -- EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PIPING SYSTEM INSULATION

- A. Sub-Freezing Piping (0 to 39°F (-18 to 4°C))
 - 1. Insulate the refrigerant suction lines between evaporators and compressors with the following type and thickness of insulation:
 - a. Fiberglass: 1" thick for pipe sizes up to and including 1", 1-1/2" thick for pipe sizes over 1".
 - b. Flexible Unicellular: 1/2" thick for all pipe sizes.
- B. Cold Piping and Domestic Hot Water Piping
 - 1. Insulate the domestic hot and cold water piping, refrigerant suction piping, and the air-conditioning condensate drain piping with the following type and thickness of insulation:
 - a. Fiberglass: 1" thickness
 - b. Flexible Unicellular: 1/2" thickness
- C. Insulation of Piping Exposed to Weather
 - 1. Protect outdoor insulation from weather by installing outdoor protective finish or jacketing as recommended by the manufacturer for HVAC piping.
- D. Hot and Chilled Water Piping
 - 1. Insulate the aboveground heating, cooling water supply, and return piping with 1" thick heavy density molded fiberglass material for piping 2" and less. Insulation thickness shall be 1-1/2" for piping 1-1/2" and larger.

3.3 DUCTWORK SYSTEM INSULATION

- A. Insulation Omitted: Do not insulate fibrous glass ductwork, or lined ductwork.
- B. Cold Ductwork (Below Ambient Temperature)

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1. Insulate the following cold ductwork:
 - a. Outdoor air intake ductwork between air entrance and HVAC unit inlet.
 - b. HVAC supply ductwork between HVAC unit discharge and room terminal outlet.
 - c. Insulate neck and bells of supply diffusers.
 - d. HVAC return ductwork between room terminal inlet and HVAC unit inlet.
 - e. HVAC plenums and unit housings not pre-insulated at factory or lined.

- C. Insulate each ductwork system specified above with 3" thick flexible fiberglass, application limited to concealed locations.

3.4 INSTALLATION OF PIPING INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation on pipe systems subsequent to installation of painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.
- F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.
- G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
- H. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band.

3.5 INSTALLATION OF DUCTWORK INSULATION

- A. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation materials with smooth and even surfaces.

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- C. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- D. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage.
- E. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated.
- F. Corner Angles: Install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.

3.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.
- B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

3.7 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

- END OF SECTION -

SECTION 15600

DUCTWORK ACCESSORIES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install all ductwork accessories as shown on the Drawings and in accordance with the Specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 15000 - Basic Mechanical Requirements
- B. Section 15500 - Basic HVAC Requirements

PART 2 -- PRODUCT

2.1 ACCESSORIES

- A. Provide deflectors and/or splitters where indicated on the plan drawings and in the details.
 - 1. Fabricate of duct gauge and material, of two thicknesses and with round nose.
 - 2. Fasten to collars, necks or take offs in such a manner as to permit manual adjustment and so as not to rattle or vibrate.
- B. Provide manually operated, opposed blade dampers where indicated and where required to balance the system.
 - 1. Shall be single or multiple blade type as required.
 - 2. Maximum single blade size shall be 12 inches x 18 inches.
 - 3. Provide accessible self locking quadrant type Ventlok No. 641 controls with handle. Mark final balanced damper position permanently on duct or shaft.
 - 4. Provide transitions for dampers larger than ducts. If smaller than duct, install a baffle plate to blank off the duct on one or two sides of the damper. If no size is indicated, damper shall be full duct size.
- C. Provide turning vanes in square or rectangular 90° elbows.
 - 1. Provide turning vanes constructed of 1-1/2" wide curved blades set at 3/4" o.c.
 - 2. Support turning vanes with bars perpendicular to blades set at 2" o.c., and set into side strips suitable for mounting in ductwork.
- D. Provide flexible duct connections at air conditioning unit connections.
 - 1. Connections to be 30 oz. UL approved neoprene coated woven glass fabric, Ventfabrics, Inc., "Ventglas", at least 4 inches wide and installed with 1 inch slack.

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- E. Include airtight, watertight flashings and sealing around all ducts or vent penetrations of walls or roof.
- F. Provide access doors in ductwork for access to all equipment and controls mounted in the ducts and otherwise where indicated or where required for cleaning.
 - 1. Doors shall be hinged, complete with gaskets and Ventlok No. 100 latches where four square feet in area or less and Ventlok No. 200 latches where over four square feet in area, and shall be insulated double panel construction for insulated ducts.
- G. Provide flexible cut where indicated, provide flexible duct runouts for supply duct mains.
 - 1. Insulated flexible air duct shall be provided of sizes indicated and not to exceed 6' in. length.
 - 2. Flexible duct shall bear UL Class I flexible air duct labels in compliance with UL Standard 181 and NFPA Standards 90A or 90B for smoke developed and flame spread ratings.
 - 3. Duct shall be constructed of galvanized wire helix encapsulated within an airtight core material covered with 1-1/2" of fiberglass insulating blanket and continuous polyethylene vapor barrier.

PART 3 -- EXECUTION

3.1 INSTALLATION OF DUCTWORK ACCESSORIES

- A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.
- B. Install turning vanes in supply and exhaust air systems.
- C. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards.
- D. Coordinate with other work, including ductwork, to interface installation of ductwork accessories properly with other work.

3.2 FIELD QUALITY CONTROL

- A. Test for air leakage while system in operation.
- B. Repair or replace faulty accessories, as required, to obtain proper operation and leakproof performance.
- C. Adjust ductwork accessories for proper settings.

- END OF SECTION -

SECTION 15950

HVAC AUTOMATIC TEMPERATURE CONTROLS

PART 1 -- GENERAL

1.1 SCOPE

- A. The Contractor shall furnish and install all HVAC Automatic Temperature Control (ATC) systems and accessories, and in accordance with the Specifications.
- B. Air conditioning equipment and controls shall be furnished and installed to operate as a system. The Contractor shall coordinate all requirements between manufacturers to insure unit responsibility and compatibility of the equipment and controls.
- C. All labor, material, equipment and software not specifically referred to herein or on the plans, which are required to meet the functional intent of this specification, including the integration to existing applications and reporting, shall be provided without additional cost to the Owner.
- D. Automatic temperature control systems indicated on the Drawings and control devices such as thermostats, etc, indicated to be 24 volts shall be supplied, mounted and wired by the ATC manufacturer. The ATC manufacturer shall size and provide low voltage transformers where required. The Automatic Temperature Control (ATC) sub-contractor shall be responsible to furnish and install the control wiring to each control device.
- E. Wiring and Conduit: 120V, 1-phase wiring and conduit to Control Panels and motorized dampers under Division 16, Electrical. All 480V 3-phase wiring and conduit shall be provided under Division 16, Electrical. Control wiring and conduit from Control Panels to field devices and equipment shall be provided by HVAC, Automatic Temperature Control Contractor. Wiring and conduit shall meet all requirements of Division 16.
- F. The work includes a BMS for the Administration Building (ADM) VAV air handling unit with gas-fired pre-heat (ADM-AHU-1), and single duct VAV boxes with electric reheat controls, temperature sensors, local controllers, and the associated programming, graphics and commissioning. The LACS as described below shall be integrated into this BMS.
- G. The Laboratory Airflow Control System (LACS) shall be furnished and installed to control the airflow into and out of critical spaces in the laboratory areas. The LACS shall vary the amount of make-up/supply air into the zone to operate the spaces at the lowest possible airflow rates necessary to maintain temperature control, achieve minimum ventilation rates and maintain room pressurization in relation to adjacent spaces (positive or negative). The LACS shall be capable of operating as a system integrated with the Building Management System (BMS) for the Administration Building.
- H. The ATC shall be capable of being expanded in future phases of upgrades on existing controls and equipment for total integration of the facility infrastructure HVAC systems. All user access to all system data over the existing HVAC network shall be available by a standard Web Browser over secured Internet/Intranet. This shall include HVAC control, energy

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management, alarm monitoring, and all trending, report and maintenance management functions related to normal building operations.

1.2 SUBMITTALS

- A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work or other mechanical and air conditioning work required, all in accordance with the requirements of Division 1, Submittals.
- B. Submit documentation in the following phased delivery schedule:
 - 1. Control equipment hardware and software.
 - 2. System schematics, including:
 - a. Sequence of operation.
 - b. Point names.
 - c. Point addresses.
 - d. Point to point wiring.
 - e. Interface wiring diagrams.
 - f. Panel layouts.
 - g. System riser diagrams.
- C. Upon completion of the work, provide a complete set of 'as-built' control drawings in AutoCAD 2009 or newer file format.
- D. The Contractor shall submit operation and maintenance manual in accordance with the procedures and requirements set forth in the General Conditions and Division 1. Operation and Maintenance Manuals shall be submitted for all equipment as follows.
 - 1. Index sheet, listing contents in alphabetical order.
 - 2. Manufacturer's equipment parts list of all functional components of the system, disk of system schematics, including wiring diagrams.
 - 3. Description of sequence of operations.
 - 4. As-Built interconnection wiring diagrams.
 - 5. User's documentation containing product, system architectural and programming information.
 - 6. Trunk cable schematic showing remote electronic panel locations, and all trunk data.
 - 7. List of connected data points, including panels to which they are connected and input device (ionization detector, sensors, etc.).
 - 8. Conduit routing diagrams.
 - 9. Copy of the warranty.
 - 10. Operating and maintenance cautions and instructions.
 - 11. Recommended spare parts list.

1.3 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to the Project Site under the provisions of Division 1.
- B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

- C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.
- D. Protect openings in casing and seal them with plastic wrap to keep dirt and debris. Protect coils from entry of dirt and debris with pipe caps or plugs.
- E. Air Terminal Unit Actuator and Unitary Controllers: ATC supplier shall furnish actuators for all motorized dampers on VAV boxes requiring actuated dampers. Contractor shall coordinate and arrange for actuators and DDC unitary controller to be shipped to air terminal unit factory for factory mounting.

1.4 MANUFACTURER'S INSTRUCTIONS

- A. Installation of all equipment shall be in accordance with manufacturer's data.
- B. All changes from the installation procedures in manufacturers' data shall be submitted for approval in accordance with the requirements for shop drawings.
- C. Keep all manufacturers' data provided in a secure manner at the job site at all times. Catalog and index this data for convenient reference.
- D. Manufacturers' data shall be available for the information of the Owner, Engineer, and the use of other trades.
- E. Turn over all data to the Owner through the Owner's representative at completion of the Work and final testing.
- F. Submit all instruction books and manuals in accordance with Division 1.

1.5 SOFTWARE LICENSE AGREEMENT

- A. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement including but not limited to:
 - 1. Graphic.
 - 2. Record Drawings.
 - 3. Database.
 - 4. Application programming code.
 - 5. Documentation.

1.6 SCHEDULES ON DRAWINGS

- A. In general, all capacities of equipment and characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. The capacities shown are minimum capacities. Variations in capacities of the scheduled equipment supplied under this Contract will be permitted only with the written direction of the Engineer.

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1.7 CODE, PERMIT AND STANDARDS

- A. Resolve any code violation discovered in contract documents with the Engineer prior to award of the contract. After award of the contract, make any correction or additions necessary for compliance with applicable codes at no additional cost to Owner.
- B. The Contractor shall obtain and pay for all permits and shall comply with all laws and codes that apply to the Work.
- C. The Contractor shall be responsible for all added expense due to his choice of equipment, materials or construction methods.
- D. All work and materials shall be in full accordance with the latest State rules and regulations or publications including those of the State Fire Marshall, the Tennessee Mechanical and Energy Codes, and all local codes. Nothing in the Plans and/or Specifications shall be construed to permit work not conforming to the above codes, rules and regulations.
- E. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. D1693, Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
 - 2. Instrumentation, Systems, and Automation Society (ISA):
 - a. S5.1, Instrumentation Symbols and Identification.
 - b. S5.4, Standard Instrument Loop Diagrams.
 - 3. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 4. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 5. Underwriters Laboratories, Inc. (UL).

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum five (5) years documented experience, who issues complete catalog data on total product. Installer shall have an established relationship with Control System Manufacturer.
- B. All material and equipment shall be the latest design, new, not deteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such material and equipment.
- C. When two or more units of the same class of material or equipment are required, they shall be products of a single manufacturer.
- D. All work shall be performed in a neat and workmanlike manner by workers skilled in their respective trades, and all materials and equipment shall be installed as recommended by the manufacturers and in accordance with specified codes and standards.
- E. Touch up and/or repaint to match original finishes for factory finished or painted equipment and materials which are scratched or marred during shipment or installation.

- F. The Manufacturer of the TCS digital controllers shall provide documentation supporting compliance with ISO-9000:2000 (Model for Quality Assurance in Design/Development, Production, Installation and Servicing). Product literature provided by the TCS digital controller manufacturer shall contain the ISO-9000:2000 Certification Mark from the applicable registrar.

1.9 ACRONYMS USED IN THIS SPECIFICATION

- A. ATC – Automatic Temperature Control.
- B. BMS – Building Management System
- C. CC – Configurable Controllers.
- D. DDC – Direct Digital Control.
- E. DRF – Discrete Render Format.
- F. GUI – Graphical User Interface.
- G. IDC – Interoperable Digital Controller.
- H. LACS – Laboratory Airflow Control System
- I. LAN – Local Area Network.
- J. NAC – Network Area Controller.
- K. ODBC – Open Database Connectivity.
- L. PICS – Product Interoperability Compliance Statement.
- M. SQL – Structured Query Language.
- N. VAV – Variable Air Volume.
- O. WAB – Web Browser Interface.
- P. WAN – Wide Area Network.
- Q. XIF – Extended Image Format.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. Product and Manufacturers: Provide control system by one of the following:
 1. Honeywell, Inc.
 2. Johnson Controls.
 3. MCC Powers Process Controls, Unit of Mark Control Corp.

- 4. Siemens Controls
- 5. Or Approved Equal.

- B. The ATC system shall be comprised of a network of interoperable, stand-alone digital controllers, a Network Area Controller (NAC), Web Browser Interface (WBI), network devices and other devices as specified herein.
- C. The installed system shall provide secure password access to all features, functions and data contained in the overall ATC.
- D. The Plans shall be taken as diagrammatic. The Contractor shall field check the existing site for detail dimensions and clearances for preparation of shop drawings. Design sizes of ducts and their locations are indicated, but not every offset, fitting, or structural obstruction is shown.
- E. Alignment of ducts may be varied where necessary to account for slight architectural changes or to avoid conflict with the Work of other trades without additional expense to the Owner.
- F. All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided, unless specifically noted otherwise.

2.2 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

- A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate the LonWorks technology communication protocols in one open, interoperable system.
- B. All controllers supplied under this contract shall be true “peer-to-peer” communicating devices.
- C. The supplied system must incorporate the ability to access all data using Java enabled browsers without requiring proprietary operator interface and configuration programs. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant database is required for all system database parameter storage. Systems requiring the owner to purchase a separate copy of proprietary database and user interface programs shall not be acceptable.

2.3 CONTROL PANELS

- A. Control panel fabrication including wiring, relays, transformers, thermostats, sensors, controllers, switches, lights and alarms shall be supplied, wired, and tested. Provide AC power supply circuit breaker in control panel, Function Devices Model Series PSH, or equal. Push-to-test pilot devices and switches shall be IDEC TWTD Series. Flow and differential pressure switches shall be United Controls 100 Series Type H100K, or equal.

2.4 FIELD DEVICES

- A. Provide automatic control valves, automatic control dampers, thermostats, clocks, sensors, controllers, and other components as required for complete installation. Except as otherwise

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indicated, provide manufacturer's standard control system components as indicated by published product information, designed and constructed as recommended by manufacturer.

- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Dampers: Size for running torque calculated as follows:
 - a. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
 - b. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
 - c. Coupling: V-bolt and V-shaped, toothed cradle.
 - d. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 - e. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
 - f. Power Requirements (Two-Position Spring Return): 24 -Vac.
 - g. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-Vdc.
 - h. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 - i. Temperature Rating: Minus 22 to plus 122 deg F.
 - j. Temperature Rating (Smoke Dampers): Minus 22° to plus 250° F.
- C. Temperature Sensors:
1. Temperature Sensors: Temperature sensors shall be linear precision elements with ranges appropriate for each specific application. CC room sensors shall provide for direct connection and access to the LonTalk network. Sensors that provide access only to their connected controller shall not be acceptable.
 2. Space (room) sensors shall have set-point adjustment and override switch. Space sensor shall have a portable service tool jack to allow communication with the LonWorks system. Digital room sensors shall have LCD display, day / night override button, and set point slide adjustment override options. The set point slide adjustment shall have software limits by the automation system to limit the amount of temperature set-point adjustment. Space sensor housing shall be constructed with ventilation slots to provide adequate airflow the ambient air space being measured.
 3. Duct mounted point sensors shall incorporate a 2x4 electrical conduit box housing.
- D. Room Thermostats
1. Provide room thermostats with locking covers, and with concealed or readily-accessible adjustment devices and dead band, as indicated.
- E. Line Voltage ON-OFF Thermostats
1. Provide thermostats of bi-metal actuated open contact, or bellows actuated enclosed snap-switch type, or equivalent solid-state type; UL-listed at electrical rating comparable with application. Provide Single Pole design. Ratings: 25 amps @ 240 volts - 22 amps @ 277 volts. Pilot Duty rated at 125 VA. Thermostat Range: 40°-100°F. Equip thermostats which control electric heating loads directly, with Off position on dial wired to break ungrounded conductors. All line voltage thermostats shall be NEMA 4x rated for corrosive environments, manufactured by PECO, Qmark, or equivalent.
- F. Local Malfunction Alarms:

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- G. Visual Warning Light: Federal Signal Corporation Model 225X Series located at entrances and exits of rooms.
- H. Audible Warning Tone: Federal Signal Corporation Model 300GCX Series located at entrances and exits of rooms.
- I. Temperature Sensors and Transmitter:
- J. Duct Temperature Averaging Type Sensor:
 - 1. Provide NEMA 4X connection head, Model CH343 by Minco Products, Inc., or equal.
 - 2. Probe case shall be 304 stainless steel.
 - 3. Connection fitting shall be Minco, Products, Inc., Model FG141, or equal.
 - 4. Minco Products, Model S14528PE, or Approved Equal.
- K. Space Temperature Sensor (Areas other than Admin Building):
 - 1. NEMA 4X, room air type sensor, Model S100147PD by Minco Products, Inc., or Approved Equal.
 - 2. Temperature Transmitter:
 - 3. Minco Products, Inc., Model TT11, or Approved Equal.
- L. Freeze-stats
 - 1. Freezestats shall be complete with SPDT snap acting switch, manual reset lever, 1/8 inch O.D. x 20' inches long Capillary tube and Capillary mounting clips. The freezestats shall have a range between 30°F and 60°F. Freezestat shall respond to lowest temperature sensed by any one foot portion of Capillary. Where required for adequate protection, multiple freezestats shall be located down stream of the heating coil. The freezestats shall de energize the heating and ventilating units if air colder than 33°F is sensed. All fans which are interlocked with the units shall stop, the units outside air dampers shall close, and a general alarm condition signal shall be provided. A time delay relay shall be provided to prevent the freezestat from shutting the system down on start-up.

2.5 LABORATORY AIRFLOW CONTROL SYSTEM (LACS)

- A. Product and Manufacturers: Provide completely factory assembled galvanized steel variable air volume boxes made by one of the following:
 - 1. Basis of Design: Phoenix Controls.
 - 2. Siemens.
 - 3. Or Approved Equal.
- B. System Function:
 - 1. The laboratory zone (rooms 867, 869, 870 and 871) shall have a dedicated airflow control system.
 - 2. The airflow control system shall maintain specific airflow ($\pm 5\%$ of signal within one second of a change in duct static pressure) regardless of the magnitude of the pressure change, airflow change or quantity of airflow control devices on either the supply air or exhaust air manifold (within 0.3" to 3.0" WC, 75 to 750 Pa, pressure drop).
 - 3. The airflow control system shall use volumetric offset control to maintain room pressurization. The system shall maintain proper room pressurization polarity (negative or positive) regardless of any change in room/system conditions, such as

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- rapid changes in duct static pressure. Systems using differential pressure measurement or velocity measurement to control room pressurization are unacceptable.
4. The airflow control system shall maintain specific airflow ($\pm 5\%$ of signal) with a minimum airflow turndown as shown in Section 2.02.A.4 to ensure accurate pressurization at low airflow and assure maximum energy efficiency.
 5. In the event of a power failure, airflow control devices shall fail to the last position and continue to maintain flow control within $\pm 5\%$ of signal within one second of a change in duct static pressure.

C. System Components:

1. Airflow Control Device - General
 - a. The airflow control device shall be a venturi valve as manufactured by Phoenix Controls® and represented by ElitAire (614) 360-1336.
 - b. The valve assembly manufacturer's Quality Management System shall be registered to ISO 9001:2008.
 - c. The airflow control device shall be pressure independent over its specified differential static pressure operating range. An integral pressure-independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure regardless of the magnitude of pressure drop (from 0.3" to 3.0" WC) (75 Pa to 750 Pa) and/or flow change or quantity of airflow controllers on a manifolded system.
 - d. The airflow control device shall maintain accuracy within $\pm 5\%$ of signal over an airflow turndown range of no less than:

Pressure Drop Across Valve	Valve Body Type	Airflow Range	Minimum Turndown
Medium 0.6-3.0" WC (150-750 Pa)	Standard	Up to 1,000 CFM (472 l/s)	20 to 1
	Standard	Up to 1,500 CFM (708 l/s)	16 to 1
	Standard	Up to 2,500 CFM (1,180	12 to 1
Low 0.3-3.0" WC (75 – 750 Pa)	Standard	Up to 1,050 CFM (495 l/s)	11 to 1
	Standard	Up to 1,400 CFM (660 l/s)	7 to 1

- e. No minimum entrance or exit straight length of duct shall be required to ensure accuracy and/or pressure independence.
- f. The airflow control device shall be constructed as one of the following types, depending upon application: Class A.
- g. The airflow control device for non-corrosive airstreams, such as supply and general exhaust, shall be constructed of 16-gauge aluminum. The device's shaft, shaft support brackets, and internal mounting link shall be made of 316 stainless steel. The pivot arm shall be made of aluminum for standard valves and 303/304 stainless steel for shut-off valves. The pressure-independent springs shall be a spring-grade stainless steel. All shaft-bearing surfaces shall be made of a PP (polypropylene) or PPS (polyphenylene sulfide) composite.

- h. A standard-speed electric actuator shall be used to modulate the airflow over the range of the specific valve size. The maximum time to modulate from minimum to maximum flow shall be less than 60 seconds for standard valves and 90 seconds for shut-off valves. A UL or CSA listed electronic actuator shall be factory mounted to the valve. The actuator shall have sufficient torque to modulate the airflow against the maximum duct static pressure (within product specifications). Loss of main power shall cause the valve to maintain its last airflow position. This position shall be maintained until power is restored. During loss of power, the valve shall maintain pressure independence.
 - i. Each airflow control device shall be factory characterized to the job specific airflows as detailed on the plans and specifications using NIST traceable air stations and instrumentation having a combined accuracy of no more than $\pm 1\%$ of signal (5,000 to 250cfm), $\pm 2\%$ of signal (249 to 100cfm) and $\pm 3\%$ of signal (99 to 35cfm). Electronic airflow control devices shall be further characterized and their accuracy verified to $\pm 5\%$ of signal at a minimum of 48 different airflows across the full operating range of the device.
 - j. Each airflow control device shall be marked with the room number, tag number, serial number, and model number. All information shall be stored by the manufacturer for use with as-built documentation.
 - k. Airflow control devices that are not venturi valves and are airflow measuring devices (e.g., pitot tube, flow cross, air bar, orifice ring, vortex shedder, etc.) shall only be acceptable provided these meet all the performance and construction characteristics as stated throughout this specification and:
 - 1) Suppliers of airflow control devices or airflow measuring devices requiring minimum duct diameters shall provide revised duct layouts showing the required straight duct runs upstream and downstream of these devices. Coordination drawings reflecting these changes shall be submitted by the supplier of the ACS. In addition, suppliers shall include static pressure loss calculations as part of their submittals. All costs to modify the ductwork, increase fan sizes and horsepower and all associated electrical changes shall be borne by the ACS supplier.
 - 2) Airflow control devices using flow measurement shall be readily removable for periodic inspection, cleaning and recalibration. Device locations and surrounding clearances shall be coordinated to allow the required maintenance.
2. Exhaust and Supply Airflow Device Controller
- a. One controller shall be provided for both the supply airflow control device and the corresponding exhaust airflow control device. The controller shall be a microprocessor-based design and use closed-loop control to linearly regulate airflow based on a digital control signal. The device shall generate a digital feedback signal that represents its airflow.
 - b. In flow tracking applications where an exhaust device and or a return device is tracking a supply device, flow data for each device (up to 3 valves total) shall be downloaded to the controller in the factory.
 - c. The airflow control device shall store its control algorithms in non-volatile, rewritable memory. The device shall be able to stand alone or to be networked with other room-level digital airflow control devices through an industry standard protocol.

- d. Room-level flow tracking control functions shall be embedded in and executed by one controller mounted on one of the airflow devices.
- e. The room-level control network shall communicate by using BACnet® MS/TP protocol. The control device must meet the requirements of a BACnet Application Specific Controller (B-ASC Level Device), and be a BACnet Testing Laboratories (BTL) certified device. Application controllers shall be of BACnet conformance class 3 and support all BACnet services necessary to provide the following BACnet functional groups:
 - 1) Files Functional Group
 - 2) Reinitialize Functional Group
 - 3) Device Communications Functional Group
- f. Refer to section 22.2 - BACnet Functional Groups, in the BACnet standard for a complete list of the services that must be directly supported to provide each of the functional groups listed above.
- g. Standard BACnet object types supported shall include as a minimum Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program object types.
- h. The airflow control device shall use 24 VAC power \pm 15%, the industry standard.
- i. The airflow control device shall be able to connect to a commissioning tool. Every node on the network shall be accessible from the BACnet Building Management System (BMS).
- j. The airflow control device shall include inputs with 10-bit resolution that accept 10K thermistors, 0–10 VDC, 0–5 VDC, 0–20 mA and dry contact signals. Controller shall include binary and analog outputs on board. Analog outputs shall be 5 VDC, 0–10 VDC, 2–10 VDC, or 0–20mA. Software shall include scaling features for analog outputs. Controller shall include a 24 Vdc voltage supply for use as power supply to external sensors.
- k. Controller shall also include support for interface with digital display which allows display and modification of controller set point variables.
- l. The airflow control device shall meet the following agency compliance requirements- FCC Part 15 Subpart J Class A, CE, and UL 916.

2.6 CONFIGURABLE CONTROLLERS (CC)

- A. Each Configurable Controller (CC) shall operate as a stand-alone LonMark® compliant controller capable of performing its specified control responsibilities independent of other controllers in the network. Each CC shall be a minimum 16-BIT microprocessor based, multi-tasking, multi-user, real time digital control processor.
- B. Each CC's application must comply with the following LONMARK® interoperability profile guidelines: Variable Air Volume (VAV) boxes - Profile 8502. Provide integral shaft-mount of one-piece VAV actuator for factory mounting by VAV box manufacturer.
- C. Flash memory reloads or updating of an existing control algorithm shall be completed over the network.
- D. Network access shall be accomplished at the CC room sensor or the CC. Where applicable, system wide node access shall be available from connecting to the room sensor jack. Systems

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that do not have a system access jack from the room sensor shall provide a dedicated network jack next to each room sensor.

- E. Controllers shall include all inputs and outputs necessary to perform the specified control sequences. Analog and digital outputs shall be industry standard signals such as 0-10V and 3-point floating control allowing for interface to a variety of industry standard modulating actuators. The CC inputs shall consist of industry standards types such as 10K thermistor, 0-10V, 4-20mA and DI. Inputs shall be electrically isolated from outputs, communications and power. All inputs shall be provided with an auto-calibrate function to eliminate sensing errors.
- F. All controller sequences and operation shall provide closed loop control of the intended application. Closing control loops over the network is not acceptable.
- G. The CC must be mounted remotely from the room sensor. CC's, that are wall mounted with integral room sensors, are not acceptable.
- H. The control program shall reside in the CC. The application program configuration information shall be stored in non-volatile memory with no battery back up.
- I. After a power failure the CC must run the control application using the current setpoints and configuration. Reverting to default or factory setpoints are not acceptable.
- J. The CC design must support pre-wiring of the hardware components where the electronics are not exposed to the harsh construction phase environment.
- K. The CC design must also support an integrated controller/actuator design for the VAV/CV zone level installations where the controller processing and I/O are contained within a single 3-point floating actuator housing.
- L. Programmable Communicating Thermostat (PCT). Must be available with and without scheduling capability with a menu-driven, back-lit LCD display. The PCT must have the ability to perform configuration directly at the thermostat, through the usage of a concealed button or via the network. Must contain two digital inputs, and, depending on the model, up to three remote sensor inputs must be available. All models with scheduler must contain a SPST auxiliary switch, which can be used to control lighting or disable the economizer function. The PCT must be capable of communicating via either native LonTalk or native BACnet.

2.7 GRAPHICAL USER INTERFACE SOFTWARE

- A. Operating System: The GUI shall run on Microsoft Windows XP Professional.
- B. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.

- C. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:
1. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.
 2. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
 3. Graphics shall support layering and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.
 4. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
 - a. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - b. Holidays shall be set by using a graphical calendar without requiring any keyboard entry from the operator.
 5. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
 6. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.
- D. System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:
1. Create, delete, or modify control strategies.
 2. Add/delete objects to the system.
 3. Tune control loops through the adjustment of control loop parameters.
 4. Enable or disable control strategies.
 5. Generate hard copy records or control strategies on a printer.
 6. Select points to be alarmable and define the alarm state.
 7. Select points to be trended over a period of time and initiate the recording of values automatically.
- E. On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.
- F. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

- G. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
- H. Alarm Console:
 - 1. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.
 - 2. When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

2.8 WEB BROWSER CLIENTS

- A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™, Mozilla FireFox™ or Netscape Navigator™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.
- B. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the TCS, shall not be acceptable.
- C. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
- D. The Web browser client shall support at a minimum, the following functions:
 - 1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
 - 2. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
 - 3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
 - 4. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
 - 5. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.
 - 6. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

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- a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
 - 1) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - 2) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
 - b. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
 - c. View logs and charts
 - d. View and acknowledge alarms
 - e. Setup and execute SQL queries on log and archive information
7. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
- E. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.9 SYSTEM PROGRAMMING

- A. The Graphical User Interface software (GUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through password access as assigned by the system administrator.
- B. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data update. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.
- C. Programming Methods:
 1. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page, and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.
 2. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming,

scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.

3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
4. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.
5. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.10 CONTROL WIRE

- A. Communication wiring shall be plenum rated three conductor cable, twisted, 100% shielded, 18-gauge wire with no splices. The wire shall be "RED (+), Black (-) and WHITE (Gnd)".

2.11 SEQUENCE OF OPERATIONS

- A. Custom Air Handling Units and interlocked exhaust systems associated with MAU-1.
 1. Refer to Sequence of Operations for these units as described in Section 15584.
- B. Electrical Room supply and exhaust fans SF-2 and Ef-2 shall be thermostatically controlled to maintain a set point on the local thermostat located within the room.
- C. Odor Control Room fans, SF-1 and EF-1 shall operate continuously.
- D. Odor Control Room unit heaters shall be thermostatically controlled to maintain a set point on the local thermostat located within the room.
- E. Odor Control fan shall operate continuously. The speed shall vary based upon the occupancy of the various spaces served. When the outdoor temperature is below 50° F and the space is unoccupied, the fan shall reduce speed to provide 50% airflow. When the space becomes occupied, the fan shall speed up to provide 100% of airflow rate. The make-up air unit shall track the exhaust fan to have a balanced air flow.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. All work described in this section shall be installed, wired, circuit tested and calibrated by the Temperature Control sub-contractor's factory certified technicians qualified for this work and in the regular employment of the temperature control system manufacturer or its exclusive factory authorized installing contracting field office (representative). The installing office shall have a minimum of five years of installation experience with the manufacturer and shall provide documentation in submittal package verifying longevity of the installing company's relationship with the manufacturer. Supervision, calibration and checkout of the system shall

be by the employees of the local exclusive factory authorized temperature control contracting field office (branch or representative).

- B. Install system and materials in accordance with manufacturer's instructions, and as detailed on the Drawings.
- C. All communication wiring shall be separate from any wiring above 30 volts.
- D. All wiring shall be labeled with BRADY style wire markers at each end.
- E. Provide signal conditioning devices and surge protection devices for Controllers, Control Panels and peripherals.
- F. Drawings of temperature control systems are diagrammatic only and any apparatus not shown, such as relays, accessories, etc., but required to make the system operative to the complete satisfaction of the Engineer shall be furnished and installed without additional cost.

3.2 WIRING

- A. The Temperature Control sub-contractor shall be responsible to furnish and install the control wiring to each control device.

3.3 ACCEPTANCE TESTING

- A. Upon completion of the installation, the Temperature Control sub-contractor shall load all system software and start-up the system. The Temperature Control sub-contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.
- B. The Temperature Control sub-contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation.
- C. Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

3.4 OPERATOR INSTRUCTION AND TRAINING

- A. During system commissioning and at such time acceptable performance of the TCS hardware and software has been established the Temperature Control sub-contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.
- B. The Temperature Control sub-contractor shall provide 40 hours of instruction to the owner's designated personnel on the operation of the TCS and describe its intended use with respect to

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the programmed functions specified. Operator orientation of the TCS shall include, but not be limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.

- C. The training shall be in three sessions as follows:
1. Initial Training: One-day session (8 hours) after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the owners' personnel can start to familiarize themselves with the system before classroom instruction begins.
 2. First Follow-Up Training: Two days (16 hours total) approximately two weeks after initial training, and before Formal Acceptance. These sessions will deal with more advanced topics and answer questions.
 3. Warranty Follow Up: Two days (16 hours total) in no less than 4-hour increments, to be scheduled at the request of the owner during the one-year warranty period. These sessions shall cover topics as requested by the owner such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

3.5 WARRANTY

- A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.
- B. Within this period, upon notice by the Owner, any defects in the TCS due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by the Temperature Control sub-contractor at no expense to the Owner.
- C. The Owner shall grant to the Temperature Control sub-contractor, reasonable access to the TCS during the warranty period. The owner shall allow the contractor to access the TCS from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.

- END OF SECTION -

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SECTION 15990

TESTING, ADJUSTING AND BALANCING

PART 1 -- GENERAL

1.1 SCOPE

- A. This section covers final testing adjusting and balancing operations after construction of the HVAC system(s).
- B. The Contractor shall secure the services of an independent testing, adjusting and balancing Agency to perform complete balance, adjustment and testing of hydronic equipment and distribution systems, including pumps, air handling units, chiller units and control systems. Agency shall have on its staff at least one certified member of the National Environmental Balancing Bureau (NEBB) who has been a member in good standing for at least 3 years, and the Agency shall be NEBB certified for a period of at least three years; or Agency shall be a member of the Associated Air Balance Council (AABC) for at least 3 years.
- C. Instruments used shall be accurately calibrated and maintained in good working condition. Equipment shall be as listed by AABC or NEBB for this type work.
- D. The Agency shall provide tests to demonstrate the specified capacities and operation of all equipment and materials comprising the system(s). Such tests other than as described herein, which are deemed necessary by the Engineer to indicate the fulfillment of the Contract, shall be made. The Agency shall then make available to the Engineer such instruments and technicians as are required for spot checks of the system.
- E. The drawings and specifications indicate valves, controls and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to install these devices in a manner that will leave them accessible and readily adjustable. The Agency shall be consulted if there is a questionable arrangement of a control or adjustable device.
- F. The Agency shall be responsible for inspecting, balancing, adjusting, testing and logging the data of the performance of the duct air distribution, controls and precision air conditioning units. The Contractor and the suppliers of the equipment installed shall all cooperate with the Agency to provide all necessary data on the design and proper application of the system components and shall furnish all labor and material required to eliminate any deficiencies or non conforming operation.
 - 1. Submit brief written report of each inspection to the Engineer, with copies to Contractor and Owner's Representative.
 - 2. Upon completion of the installation and start-up of the mechanical equipment by the Contractor, Agency shall balance, test and adjust the system(s) components to obtain optimum conditions in each conditioned space in the building.
 - 3. Prior to Final Application for Payment, the Contractor shall submit copies of the completed Testing, Adjusting and Balancing Report. The Testing, Adjusting and Balancing Report shall be complete with logs, data, and records as required herein.

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4. The Report shall contain the following general data:
 - a. Project No.
 - 1) Contract No.
 - 2) Project Title:
 - 3) Project Location:
 - 4) Engineer: (Name)
 - 5) Field Test Engineer: (Name)
 - 6) Testing Diagnosis and Analysis by: (Name)
 - 7) Agency: (Firm name, telephone number and address)
 - 8) Contractor: (Name and address)
 - 9) Inclusive dates tests were performed and date of Report
 - 10) Test Certification Number:
 - 11) Certification by Agency's Principal Engineer
 - b. The Testing Adjusting and Balancing Report shall contain the following sections:
 - 1) Table of Contents
 - 2) General data and certification
 - 3) Brief Description of Tests and Test Procedures (including instruments used)
 - 4) Summary of Test Results (note deficiencies, if any, and action taken for correction)
 - 5) Logs, Data, and Records

1.2 REFERENCES

- A. AABC - National Standards for Field Measurement and Instrumentation, Total System Balance.
- B. NEBB - Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.3 PROCEDURES

- A. Operating Tests. After all mechanical systems have been completed, and prior to balance, subject each system to an operating test under design conditions to ensure proper sequence of operation in all operating modes. Make adjustments as required to ensure proper functioning of all systems.
- B. Certified Data. The Contractor shall provide the Agency with the certified data on pumps, chillers and other equipment required for proper balancing of the system.
- C. Adjustment. The Agency shall supervise or perform necessary adjustments to valves, pumps and other controls as required to properly balance the system.
- D. Balancing. The Agency shall follow balancing and testing procedures published by the AABC, or NEBB.
- E. Reports: Compile the test data on report forms as listed in the AABC "National Standards for Total System Balance".

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1.4 SUBMITTALS

- A. Submit Testing, Adjusting and Balancing Report as a Shop Drawing submittal under the provisions of Division 1, General Requirements.

PART 2 -- PRODUCTS
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PART 3 EXECUTION

3.1 TESTING, ADJUSTING AND BALANCING

- A. General Requirements
 - 1. Do all work required for complete testing, adjusting and balancing of all systems.
 - 2. Provide all instruments and equipment required to accomplish necessary testing, adjusting and balancing, and as required to verify performance. All instruments shall be in accurate calibration.
 - 3. Prior to Final Application for Payment, submit a letter certifying:
 - a. That all balancing is complete.
 - b. That all controls are calibrated and functioning properly.
 - c. That all parts of the various systems are complete and ready to be turned over to the Owner for continuous operation.
- B. Record, and Submit the following data for constant-volume supply and return air systems.
 - 1. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.
 - 2. Measure fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 3. Measure static pressures across each air handling unit component.
 - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
 - b. Adjust fan speed higher or lower than design with the approval of the Engineer. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
 - c. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.

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- C. Adjust volume dampers for main duct, sub main ducts, and major branch ducts to design airflows within specified tolerances.
 - 1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
 - a. Where sufficient space in sub mains and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 - 2. Re measure each sub main and branch duct after all have been adjusted. Continue to adjust sub mains and branch ducts to design airflows within specified tolerances.
- D. Measure terminal outlets and inlets without making adjustments.
 - 1. Measure terminal outlets using a direct-reading hood or the outlet manufacturer's written instructions and calculating factors.
- E. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.
 - 1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.
- F. Record, and Submit the following data for each air handling unit cooling coil apparatus:
 - 1. For each evaporator and condenser coil (when applicable):
 - a. Cooling Capacity.
 - b. Refrigerant.
 - c. Compressor Voltage, Amps and Phase (Design\Actual).
 - d. No. of Compressors.
 - e. Size of Compressors.
 - f. Compressor suction and discharge pressures.
 - g. Sound Level including location of test points and octave bands readings with unit off and on.
 - 2. For each test instrument used:
 - a. Instrument/Serial No.
 - b. Application.
 - c. Dates of use.
 - d. Calibration test date.
 - 3. For each air handling unit:
 - a. Identification Number.
 - b. Manufacturer.
 - c. Size/Model Number/Serial Number.
 - d. Cooling capacity (Design\Actual).
 - e. Heating capacity (Design\Actual).
 - f. Air flow (Design\Actual).
 - g. Fan RPM (Design\Actual).
 - h. Outside air flow rate (Design\Actual).
 - i. Motor actual amperage and voltage at balanced flow rate.
 - j. Motor Nameplate full load amperage, voltage, phase, hertz, service factor, type, model number, serial number and frame number.

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4. For each air device:
 - a. Identify location and area of each.
 - b. Air flow CFM rate (Design/Actual).
 - c. Identify and list size, type and manufacturer of diffusers, grilles, registers, and variable air box equipment.
 5. For each site visit:
 - a. Date.
 - b. Time.
 - c. Outdoor Temperature (Wet Bulb and Dry Bulb).
 - d. Indoor Temperature (Wet Bulb and Dry Bulb).
- G. Each control component shall be tested and verified, including but not limited to the following:
1. Sensors.
 2. Interlocks.
 3. Hand-off-auto switches.
 4. Control sequences.
 5. Safety devices.
- H. After Owner has accepted the systems, make two additional inspections of the system over a one year period (one during winter operation and 1 during summer operation) to:
1. Correct any Owner observed temperature imbalances.
 2. Check correct operation of equipment and verify by letter to the Engineer on each trip. List in the letter corrections made.
- I. At Time of Job Completion
1. Provide such tools, equipment and personnel as required to conduct tests and demonstrate the acceptability of the various systems.
 2. Have the authorized representatives of the various equipment manufacturers available if requested.

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SECTION 16010

GENERAL ELECTRICAL, INSTRUMENT, AND CONTROL REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. General requirements for electrical power, instrumentation, and controls systems.

1.2 RELATED SECTIONS

- A. Section 01000 – General Specifications.
- B. Section 16050 – Basic Electrical Materials and Methods.

1.3 REFERENCES

- A. All equipment and workmanship shall be in conformance with the following documents:
 - 1. National Electrical Code, latest approved edition.
 - 2. Any and all Federal, State, and/or local codes, ordinances, or regulations.
 - 3. Latest approved standards of ISA, IEEE, ANSI, NEMA, and Underwriters' Laboratories.
- B. All equipment shall be designed, constructed, installed, and tested in conformity with all requirements, as a minimum, of applicable standards of IEEE, NEMA, ISA, ANSI, ICEA, and OSHA, except as modified herein.

1.4 GENERAL REQUIREMENTS

- A. Unless otherwise specified, provide tools, equipment, apparatus, transportation, labor, and supervision to complete and place in satisfactory operation the work indicated on the Drawings and specified herein. Where permits or inspection fees are required in connection to the work under this Specification, the Contractor shall secure such permits and pay all fees.
- B. Where any public or private utilities are encountered, the Contractor shall be responsible for any damages thereto resulting from his operations. Any existing lines or utilities damaged during the construction and which are not to be abandoned or removed, shall be replaced or repaired. The Contractor shall be responsible for determining the exact location of all underground or otherwise concealed utilities, conduit runs, piping, etc. which may interfere with construction or which require modifications.
- C. All work shall be done in conformity with the applicable requirements of the codes, rules, and regulations of public utilities and all others having jurisdiction.
- D. Where the Specifications describe or the Drawings show materials of higher quality than required by the above rulings and codes, the Drawings and Specifications shall govern the quality of materials which shall be furnished.

- E. The wire, conduit, and equipment sizes shown on the Contract Drawings are based on estimated ratings. If ratings of equipment as furnished under the Contract exceed the estimated ratings, the wire, conduit, and equipment sizes shall be adjusted to meet NEC requirements at no additional cost to the Owner.
- F. The phrase "below grade," when used in reference to the interior of buildings, rooms, or other structures in these Specifications and on the Drawings, shall apply to the entire internal volume of the room, area, or structure where 50% or more of the volume is actually below the average of the exterior finished grade elevations. In all other cases, the phrase shall only apply to the volume of space actually below finished grade.
- G. Dry locations are defined as interior; above grade; heated rooms, structures, buildings, cabinets, enclosures, etc. not normally subject to dampness or wetness. Damp locations are defined as interior; above grade; unheated rooms, structures, and buildings. Wet locations are defined as all outdoor areas; all underground rooms, structures, building areas, vaults, etc.; whether heated or unheated. Refer to National Electrical Code Article 100, "Location:" for additional definitions.

1.5 PROJECT CONDITIONS

- A. Before submitting his proposal, this Contractor shall be held to have examined the site and satisfied himself as to the existing conditions under which he will be obliged to work. The Contractor will be allowed no claim(s) for extra(s) due to his failure to make the above examination.

1.6 INSPECTION

- A. At the proper time, the Contractor shall file application for inspection of his work with the local, State, or National authority having jurisdiction and shall deliver to the Owner all required certificates attesting to approval by such authorities.

1.7 GUARANTEE

- A. The equipment and installation furnished under this Section shall be guaranteed for a period of one (1) year as specified under Section 01700, Contract Closeout, except as modified by the Division 16 Specifications.
- B. Repair and maintenance for the guarantee period is the responsibility of the Contractor and shall include all repairs and maintenance other than that which is considered as routine. (This is replacement of lamps, oiling, greasing, etc.) The Owner shall be the judge of what shall be considered as routine maintenance.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be new, except where specifically identified otherwise.

- B. All materials and equipment shall be listed or labeled by Underwriters' Laboratories, Inc., except for materials and equipment not available from any source with such listing and/or labeling, or as specifically required by the Division 16 Sections.
- C. All conductor terminations, lugs, and connectors on all equipment supplied under this Contract shall be 75°C rated for copper conductors.
- D. Concrete for electrical work shall be as specified in Section 03300.

2.2 LOOSE AND DETACHABLE PARTS

- A. The Contractor shall retain all loose and small detachable parts of the apparatus and equipment furnished under his Contract, until the completion of his work, and shall then turn same over to the Owner or his representative delegated to receive them and obtain from the Owner an itemized receipt, therefore, in triplicate, the Owner retaining the original. The Contractor shall retain one copy of this receipt for his files and shall attach the other two to any request for final payment for the work.

2.3 STANDARDS

- A. All materials shall be new and shall conform as a minimum with NEMA, ANSI, and Underwriters' Laboratories, Inc. (UL) in every case where such a standard has been established for the particular type of material in question.

2.4 SPARE PARTS

- A. Spare parts shall be provided for electrical equipment supplied under this Contract, as specified in individual Specification Sections, and shall be furnished and delivered to the Owner. Spare fuses are specified under Section 16477.
- B. Spare parts shall be packed and individually boxed for storing with each box labeled with the part's description including its part or catalog number, its use, and the equipment for which it is a part. Parts used during startup shall be replaced prior to acceptance.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

- A. All floor mounted equipment shall be provided with a minimum 4 inch high concrete pad, unless a higher dimension is shown (or called for) on the Drawings.
- B. Material and equipment furnished and installed by the Contractor shall be completely protected against damage, pilferage, dampness, or abuse until turned over and accepted by the Owner.
- C. Concrete shall be maintained in moist condition for at least five (5) days after placement, by means approved by the Owner.

- D. The installation of all electrical, instrumentation, and control equipment shall meet the requirements of the State and Federal Occupational Safety and Health Statutes.

3.2 DRAWINGS AND MEASUREMENTS

- A. Drawings shall be submitted in accordance with Sections 01300 and 01700 of these Specifications and as specified hereinafter. No work shall be undertaken until the Engineer has reviewed and approved the shop drawings. Only approved materials shall be installed and only approved installation methods shall be used.
- B. The Drawings show the arrangement, general design, and extent of the systems. The work is shown on the Drawings by symbols, as shown in a legend on the Drawings. Equipment is shown in its general location, except where in certain cases the Drawings may include details giving the exact location and arrangement. Existing, underground or otherwise concealed utilities, piping, conduit runs, etc. indicated on the Drawings are shown in approximate locations and orientations only; the Contractor shall field verify exact locations.
- C. The Drawings are not intended to be scaled for roughing-in measurements nor to serve as shop drawings. Where drawings are required for these purposes or have to be made from field measurements, they shall be prepared by the Contractor. Field measurements necessary to determine the required quantities of materials and fitting the installation of all materials and equipment into the building construction shall be taken by the Contractor.
- D. Installation drawings and manufacturer's shop drawings are required for all electrical, instrumentation, and control work. Installation drawings shall show panel layout, conduit connection sizes, and location and equipment foundations, details, and locations, accurately dimensioned. Exposed runs of conduit need not be dimensioned. Conduit layout and installation drawings shall be submitted for approval and shall show all conduit runs, complete from origination to termination, and shall indicate conduit sizes and fills, raceway system components, methods and spacing of supports, etc.
- E. Control schematics shall be provided for all new and modified existing control circuits. Control schematics shall use the ladder diagram type format incorporating line numbers, operation function statements, contact location line numbers with underlines indicating normally closed contacts. A description of operation of each device and complete written sequence of operation shall be provided with all control schematics. Format and symbols shall be as approved by the Owner. Wire and terminal numbers shall be clearly shown.
- F. Upon completion of the work, complete "As-Built" drawings shall be provided. For additional requirements see Section 01700, Contract Closeout, Project Record Documents.

3.3 STORING OF EQUIPMENT

- A. All equipment shall be stored in accordance with the manufacturer's recommendations. A letter from the manufacturer shall be provided stating those recommendations.
- B. All equipment which has been set in place but not in operation shall be protected from damage or deterioration from whatever causes in accordance with the manufacturer's recommendations until the equipment has been accepted by the Owner.

- C. All wire and cable shall be stored on the original, manufacturer's reels, protected from the weather, and all cable end seals shall be maintained intact until the cable is installed.
- D. During construction, all electrical equipment insulation shall be protected against absorption of moisture and metallic components shall be protected against corrosion by strip heaters, lamps, or other acceptable means. This protection shall be provided immediately upon receipt of the equipment and maintained continuously.

3.4 CLEANUP

- A. After substantial completion and prior to final acceptance, all electrical equipment shall be cleaned up, interior and exterior, to be free of dust and other foreign matter. Internal components shall be vacuumed, including windings of dry type transformers, and wiped free of dust.
- B. De-energization of equipment to accomplish the cleaning work shall be done at a time as approved by the Owner.

3.5 PAINTING

- A. The exterior of all enclosures shall be cleaned and touched up with matching paint where scratched or marred so that the exterior presents an "as new" appearance.
- B. All factory finished equipment shall be protected from damage during erection, thoroughly cleaned after erection, and touched up as required. If the factory finish has, in the opinion of the Owner, been seriously damaged, the equipment shall be refinished.

3.6 SALVAGED ELECTRICAL EQUIPMENT

- A. All electrical equipment in the existing facility that is removed and not reused shall be turned over to the Owner or disposed of as directed by the Owner.

3.7 SUBSTANTIAL COMPLETION

- A. Substantial Completion is the stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete, in accordance with the Contract Documents, such that the Owner can occupy the facilities and/or utilize the system for its intended use.
- B. Substantial Completion shall be determined by the Owner and/or the Engineer based on completion of Testing, Start-up, and Demonstration requirements as specified in Sections 16960, 16970, and 16980. See Section 01700, Contract Closeout for additional requirements.

END OF SECTION

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. General electrical equipment and installation requirements.

1.2 RELATED SECTIONS

- A. Section 01000 – General Specifications.
- B. Section 16010 – General Electrical, Instrument, and Control Requirements.

1.3 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Short Circuit, Flash Hazard, and Protective Devices Coordination Analyses: Submit per paragraph 3.3.
- C. Temporary Power Plan and Schedule: Submit proposed sources of temporary power, means of power distribution, protection of temporary cables, and schedule of any power outages required.

1.4 WORK INCLUDED

- A. The Contractor shall furnish all labor, material, and equipment required for the installation of the modifications to existing electrical systems and the completion of the work as herein specified and/or indicated on the Drawings. It is the intent that the Drawings and Specifications, which are general only, shall provide for finished, first-class work, and that the equipment and appurtenances thereto shall be of such construction and details, and of such materials, as to function completely and properly, and so as to be of long life; and such as not to require excessive upkeep or maintenance; and that operation shall be simple and control convenient. Any items omitted therefrom which are clearly necessary for the completion of the work or its appurtenances shall be considered a portion of the work though not directly specified or shown. All work shall conform with NECA 1-2010, Good Workmanship in Electrical Contracting.
- B. The Contractor shall install and wire all remote mounted heating and ventilating thermostats, electrical components, and control panels furnished by the mechanical equipment suppliers.
- C. The Contractor shall install and wire all electric resistance heaters and any associated, remote mounted thermostats furnished by the mechanical equipment suppliers.

- D. The Contractor shall provide and install all conduit and wire connections required between components of equipment and systems supplied under other Sections of these Specifications and on the Drawings.
- E. The Contractor shall furnish and install modifications to existing secondary power distribution systems.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. The Contractor shall furnish and install modifications to the existing power distribution system, together with all necessary supports, framing, hangers, and all other appurtenances. He shall furnish and arrange for the setting of anchor bolts, channels, etc. which are to be set in the concrete. He shall connect and make operable any and all electrical equipment whether or not it was furnished under this section of the Specifications. The work shall include, but is not limited to, the following items:
 - 1. Motor Starters
 - 2. Variable Frequency Controllers
 - 3. Distribution Panelboards
 - 4. Electrical Equipment and Devices
 - 5. Raceway System
 - 6. Power Feeder and Branch Circuit Wiring
 - 7. Modifications to Existing Motor Control Centers
 - 8. Disconnect Switches
 - 9. Transfer Switches
 - 10. Surge Protection Devices

PART 3 EXECUTION

3.1 TEMPORARY POWER FOR CONSTRUCTION

- A. The Contractor shall be responsible for providing temporary electrical power as required during the course of construction and shall remove temporary service equipment when no longer required. Temporary power sources shall be installed per NECA 200-2010, Temporary Electric Power at Construction Sites, Standards.
- B. Portable, diesel, engine-generator sets may be utilized for temporary power to maintain loads during construction. Each engine-generator set shall be sized to adequately handle the intended load, including largest motor starting with all other loads running. The following shall be submitted for each engine-generator set and approved prior to use:
 - 1. A schedule indicating loads served, starting date, ending date, set size, and location on the site; coordinate with the Sequence of Construction and Demolition hereinafter.
 - 2. Generator sizing calculations including load tabulation and motor starting sequence.
 - 3. Engine-generator set data including size, manufacturer, catalog number, load cable size and type, and load connection location.

Each engine-generator set shall be secure during use and shall be maintained for efficient and continuous operation. The Contractor shall provide all necessary fuel, replenished to ensure continuous operation, and maintenance required during use.

Load cables shall be routed and protected to prevent damage and to prevent exposing personnel to hazards. Cables shall be of the heavy duty jacketed type, Bronco/66 Type G cable as manufactured by Teledyne Western Wire Co., Essex Type G, or equal.

Engine-generator sets shall be as manufactured by Kohler Power Systems, Cummins Power Generation, Caterpillar, Inc., or equal.

3.2 DRAWINGS AND MEASUREMENTS

- A. Outlets connected by lines show switch control or circuiting only and are not actual runs of conduit. All light and receptacle outlets are lettered and numbered; the letter indicates the panelboard from which the circuit is to be powered. All outlets bearing the same letter and number shall be connected to the same circuit.
- B. Power feeders shall be run in individual conduits, from source to load, as indicated in schedules, wiring diagrams, or by home runs on the Drawings.

3.3 SHORT CIRCUIT, FLASH HAZARD, AND PROTECTIVE DEVICES COORDINATION ANALYSES

- A. A power system short circuit analysis shall be provided by the Contractor to analyze the electrical system and verify the correct application of the power system devices and other power system components provided under this Contract. This and the following flash hazard and coordination analyses shall be carried from the Substation No. 1 switchgear through the branch circuit protective devices. The analyses shall include all existing electrical distribution system components to remain in service. The Contractor shall obtain all information necessary to perform the short circuit calculations. Perform field inspections as required to obtain all information. Contact DTE Energy as required to obtain utility fault current contribution information.
- B. A flash hazard analysis shall be provided by the Contractor to determine the flash protection boundary and the level of personal protective equipment (PPE) required for each switch enclosure, panel, device, and equipment containing electrical circuits per NFPA 70E. The results of this analysis shall be used to prepare arc-flash and shock hazard warning labels for electrical equipment enclosures, where required by the National Electrical Code.
- C. A protective devices coordination analysis shall be provided by the Contractor to analyze and verify the selection and settings of the protective devices in the electrical system. Devices shall be selected to provide a maximum of circuit protection and selectivity consistent with a maximum in service continuity. Composite coordination curves shall be provided by the Contractor to verify that selectivity will be provided by the devices used.
- D. Provide two (2) bound documents, each of which shall include complete short circuit, flash hazard, and protective devices coordination analyses, including device coordination and time-current curves for the distribution system protective devices.

- E. In the short circuit analysis, provide calculation methods and assumptions, the base quantities selected, one-line diagram, source impedance data (including power company system characteristics), impedance diagrams or data tables, typical calculations, tabulations of calculated quantities and results, conclusions, and recommendations. Provide calculated short circuit interrupting and momentary duties for an assumed three phase bolted fault at significant locations throughout the distribution system. Include in the tabulations: fault impedance, X/R ratios, asymmetry factors, motor contribution, short circuit kVA, and symmetrical and asymmetrical fault currents. Calculations shall be of the per unit impedance method on a 100 MVA or 1,000 kVA base.
- F. The flash hazard analysis shall include calculations of the flash protection boundary and incident energy for each piece of electrical equipment utilizing the formulas in the current edition of NFPA 70E and IEEE Standard 1584. The analysis results shall include the following for each piece of electrical equipment:
1. Nominal System Voltage
 2. Arc Flash Boundary in inches.
 3. Available Incident energy and the corresponding working distance in calories per square centimeter (cal/cm²) and/or minimum arc rating of clothing and/or site-specific level of PPE
 4. Limited approach distance (when door or cover is open) in inches.
 5. Restricted approach distance (when door or cover is open) in inches.
- G. In the protective devices coordination analysis, provide time-current curves graphically indicating the coordination proposed for the system, including ground fault protection, centered on conventional full size log-log paper. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portions of the system covered by that particular curve sheet. Each curve sheet shall display curves for a maximum of four (4) protective devices. Include a detailed description of each protective device identifying type, function, and degree of coordination achieved. Tabulate recommended device pick-up, instantaneous, and time delay settings.
- H. Include on the curve sheets power company relay and fuse characteristics, medium voltage equipment relay and fuse characteristics, low voltage equipment circuit breaker trip device and fuse characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. Include all devices down to the low voltage feeder breakers. Include transformer deconstruct curves (ANSI method; including thermal and mechanical stress limits) and significant symmetrical and asymmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed.
- I. The short circuit, flash hazard, and protective devices coordination analyses may be prepared with a digital computer or by written calculations, but must include complete fault tabulations.
- J. The short circuit, flash hazard, and protective devices coordination analyses shall be provided by an electrical power distribution equipment manufacturer or an electrical distribution systems analyst. Analyses shall be performed and prepared by UIS, PowerPlus Engineering, Northern Electrical Testing, or approved equal.
- K. The Drawings and Specifications indicate the general requirements for the electrical equipment being provided. Changes and additions to equipment characteristics may be

suggested by the results of the short circuit, flash hazard, and protective devices coordination analyses. Submit any such proposed changes and additions as a part of the analyses document. Necessary field settings of devices, adjustments, and modifications to equipment to accomplish conformance with the approved short circuit, flash hazard, and protective devices coordination analyses shall be carried out by the particular manufacturer or by the Contractor at no additional cost to the Owner. Required field settings and adjustments shall be made on existing protective devices also.

3.4 SCHEDULING

- A. The Contractor shall be responsible for coordinating and scheduling his work to minimize disruption of the Owner's operations. The Contractor shall schedule all service interruptions at times as approved by the Owner and shall notify the Owner, at least 1 week in advance, of any scheduled power interruption during construction.
- B. The Contractor shall include all details of the sequencing the work in a schedule of work. The schedule of work shall include work to be performed relative to time of material delivery and length of time for installation and shall be coordinated with permissible outage times as determined by the Owner. The schedule shall be submitted for approval prior to the start of work.

END OF SECTION

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SECTION 16110

RACEWAYS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Metal conduit.
- B. Flexible metal conduit.
- C. Liquidtight flexible metal conduit.
- D. Non-metallic conduit.
- E. Fittings and conduit bodies.

1.2 RELATED SECTIONS

- A. Section 16010 – General Electrical, Instrument, and Control Requirements.
- B. Section 16050 – Basic Electrical Materials and Methods.
- C. Section 16130 – Boxes.
- D. Section 16170 – Grounding and Bonding.
- E. Section 16190 – Supporting Devices.
- F. Section 16195 – Electrical Identification.

1.3 REFERENCES

- A. ANSI C80.1 – Rigid Steel Conduit, Zinc Coated.
- B. ANSI C80.3 – Electrical Metallic Tubing, Zinc Coated.
- C. ANSI/NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
- D. ANSI/NFPA 70 – National Electrical Code.
- E. NECA 101-2013, Steel Conduits (Rigid, IMC, EMT).
- F. NECA 111-2003, Standard for Installing Non-metallic Raceways.
- G. NEMA RN 1 – Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

- H. NEMA TC 2 – Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
- I. NEMA TC 3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing.
- J. UL 6 Standard for Rigid Metal Conduit.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Shop Drawings: Conduit layout and installation drawings shall be submitted for approval and shall show all conduit runs, complete from origination to termination, and shall indicate conduit sizes and fills, raceway system components, methods and spacing of supports, etc. Indicate materials, finishes, dimensions, listings, and standards compliance.
- C. Product Data: Provide data for conduit, tubing, duct, fittings, and accessories.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle Products to site under provisions of Section 01600.
- B. Accept conduit on site. Inspect for damage.
- C. Conduit shall be delivered at the construction site in not less than ten foot lengths; each length of conduit to have approval label of the Underwriters.
- D. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- E. Protect PVC conduit from sunlight.

1.6 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Verify routing and termination locations of conduit prior to rough-in.
- C. Conduit routing is shown on Drawings in approximate locations, unless dimensioned. Route as required to complete the raceway system.

PART 2 PRODUCTS

2.1 CONDUIT AND FITTINGS

- A. Provide all conduit, conduit fittings, outlet boxes, pull boxes, supports, hangers, plates, and such other items as are incidental to or required for a complete installation, all of which shall be made of cast iron, malleable iron, or galvanized steel, unless indicated otherwise.
- B. No threadless couplings or running threads will be permitted on rigid conduits.
- C. No conduit smaller than 3/4 inch shall be used, unless otherwise indicated or specified.
- D. All raceways shall be marked with the manufacturer's name or trademark as well as type of raceway and size. This marking shall appear at least once every 10 feet and shall be of sufficient durability to withstand the environment involved.
- E. Wherever conduits cross building, tank, or other structural expansion joints, the Contractor shall provide and install conduit expansion/deflection fittings as manufactured by O.Z./Gedney Type DX, Crouse-Hinds, Thomas & Betts, or equal, unless indicated on the Drawings as requiring an expansion fitting.
- F. Expansion fittings with copper, ground bonding jumpers shall be installed where indicated on the Drawings and shall be O.Z./Gedney Type AX with Type BJ bonding jumper, Crouse-Hinds, or equal.

2.2 RIGID STEEL CONDUIT

- A. Rigid steel conduits shall consist of heavy wall, mild steel tube, hot-dipped galvanized with threads electrogalvanized after cutting, and especially selected with reference to uniformity of thickness and freedom from defects. All fittings shall be suitable and approved for use in rigid steel conduit systems.
- B. Manufacturers:
 - 1. Wheatland Tube Company
 - 2. Allied Tube & Conduit Corporation
 - 3. Maverick Pipe
 - 4. Or Approved Equal
- C. Rigid Steel Conduit: ANSI C80.1, UL 6.
- D. Fittings and Conduit Bodies: ANSI/NEMA FB 1; UL Standard 514B; all steel fittings.

2.3 PVC COATED METAL CONDUIT AND FITTINGS

- A. Manufacturers:
 - 1. ABB Ocal Blue
 - 2. Robroy Industries Plasti-Bond Red H₂O_T
 - 3. Or Approved Equal

- B. Description: NEMA RN 1; rigid steel conduit with external PVC coating, 40 mil thick. UL listed with the PVC coating as the primary corrosion protection.
- C. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel fittings with external PVC coating to match conduit. UL listed with the PVC coating as the primary corrosion protection.
- D. PVC coated conduit, fittings, and fasteners shall all be supplied from the same manufacturer.
- E. PVC coated conduit shall be rigid metal conduit factory encased with polyvinyl chloride of .040 inch (40 mil) thickness minimum on the exterior and a urethane coating of .002 inch (2 mil) thickness nominal or a phenolic coating of .003 inch (3 mil) thickness nominal on the interior. The adhesion of the coating shall be greater than the tensile strength of the coating (NEMA RN1 requires a minimum tensile strength of 2000 psi for PVC).
- F. All fittings and fasteners shall have the same PVC coating on the exterior as the conduit. All hollow fittings shall also have the same interior coating as the conduit. Couplings, fittings, and conduit bodies shall have PVC sleeves at threaded joints with length equal to the outside diameter of the associated conduit or 2 inches. Conduit body covers shall be provided with stainless steel screws with PVC coated, hex heads.

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Manufacturers:
 - 1. Anaconda “Sealtite” Type LA
 - 2. Electriflex
 - 3. AFC
 - 4. Thomas & Betts Corp.
 - 5. Or Approved Equal
- B. Description: Interlocked steel construction with PVC jacket.
- C. Fittings: ANSI/NEMA FB 1.
- D. All fittings used with this conduit shall be of the liquidtight type and shall be equipped with approved type grounding devices to insure continuity between the conduit and the connection. The fittings shall seal out vapors, coolants, oil, water, dust, and other foreign matter and shall be installed with a sealing O-ring between the fitting and the box. The fittings shall be “ST” series connections as manufactured by Appleton Electric Co., Ideal Industries 75-000 Series, or equal.

2.5 NON-METALLIC, PVC CONDUIT

- A. Manufacturers:
 - 1. Thomas & Betts – Carlon
 - 2. JM Eagle
 - 3. Osburn Associates, Inc.
 - 4. IPEX - Scepter
 - 5. Cantex
 - 6. Or Approved Equal

- B. Description: NEMA TC 2; Schedule 40 PVC.
- C. Fittings and Conduit Bodies: NEMA TC 3.
- D. Plastic (PVC) conduit shall be heavy wall, Schedule 40 with integral bell, polyvinyl chloride (PVC), non-metallic conduit.

2.6 MISCELLANEOUS FITTINGS AND MATERIALS

- A. Insulated grounding bushings shall be Type HBLG as manufactured by O.Z./Gedney, American Fittings Corp., Thomas & Betts, or equal.
- B. Insulating bushings shall be high impact resistant, thermoset plastic, 150°C rated, Type A as manufactured by O.Z./Gedney, American Fittings Corp., Thomas & Betts, or equal.
- C. All locknuts shall be of the sealing type, O.Z./Gedney Type SLG, Appleton, American Fittings Corp., Thomas & Betts, or equal.
- D. Liquidtight hubs shall have a sealing ring between the fitting and the box and an insulated throat to insure protection of the wires as pulled. Hubs shall be made of nodular or malleable iron steel, zinc plated for corrosion resistance, UL listed, and shall meet or exceed the requirements of UL test 514B. Liquidtight hubs shall be Bridgeport, O.Z./Gedney Type CHM, Ideal Industries 75-000 Series, American Fittings Corp., Thomas & Betts, or equal.
- E. Sealing fittings shall be Crouse-Hinds Co. Type EYS, Appleton, or equal. Sealing fittings used as water stops shall have an integral drain and shall be Crouse-Hinds Type EYD, Appleton, Thomas & Betts, or equal. Sealing fittings in hazardous or corrosive areas shall be PVC coated.
- F. Explosion proof, flexible conduit couplings shall consist of a braid cover over a flexible inner core with suitable end fittings. Flexible couplings shall be all stainless steel construction, Crouse-Hinds Type EC-S516, Appleton, or equal.
- G. Couplings and fittings for electrical metal tubing shall be zinc plated steel compression or setscrew connectors and couplings as manufactured by O.Z./Gedney, American Fittings Corp., Thomas & Betts, or equal.
- H. Conduit sealing compound shall be Watguard Desiccants Industrial Encapsulant, Polywater FST-250, or equal.
- I. Link seal for sealing conduits into sleeves and cored openings shall be GPT Industries - Thunderline, Metraflex Co. Metraseal, Calpico, or equal.

PART 3 EXECUTION

3.1 INSTALLATION OF RACEWAYS

- A. Install conduit in accordance with NECA 101-2013, Steel Conduits (Rigid, IMC, EMT).

- B. Arrange supports to prevent misalignment during wiring installation.
- C. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
- D. Do not attach conduit to ceiling support wires.
- E. Arrange conduit to maintain headroom and present neat appearance.
- F. Identify raceway systems under provisions of Section 16195.
- G. Joints shall be made tight with standard couplings and corners turned with elbows or long radius bends in pipe.
- H. Exposed multiple runs of conduit indoors shall be supported on hangers suspended from concrete inserts or structural steel. Single runs of conduit may be attached to ceilings or walls by means of approved type anchors. Conduit and other equipment may be attached to structural steel only where approved by the Owner. All conduit shall be secured to the supports by means of galvanized malleable iron clamps using two bolts or machine screws. Conduit supports, hangers, and anchors shall be as specified under Section 16190.
- I. The use of wood plugs for anchoring raceways to concrete or masonry will not be permitted.
- J. All conduits installed exposed shall be run vertically or horizontally and shall be parallel or at right angles to the building or structure walls.
- K. The Contractor shall provide and install, where required, the additional steel to adequately support all conduits, boxes, and all other electrical equipment.
- L. All conduit shall be dry, clean, and free of obstructions before conductors are pulled in. If there is evidence of moisture, obstructions, or foreign matter in the conduit when the conductors are installed, the wiring shall be removed and the conduit cleaned to the satisfaction of the Owner. All wiring showing evidence of damaged insulation shall be replaced.
- M. Concealed conduit shall be placed in floors, ceilings, and walls before concrete is poured and in masonry walls as the walls are laid up. The conduit shall be blocked and fastened in place to prevent any displacement during construction. Conduits shall be separated by at least one conduit diameter, unless specifically authorized by the Owner to do otherwise. All conduit joints shall be made tight with galvanized couplings or approved unions.
- N. All steel conduit run exposed shall be supported at intervals not exceeding 8 feet, unless shown otherwise on the Drawings. Multiple runs of conduit shall be mounted with steel supports so arranged that each individual conduit is clamped in place.
- O. Conduit installed on walls shall be mounted on spacers to provide not less than 1/4 inch space between the conduit and the wall.
- P. Conduit installed exposed outdoors shall be supported by structural steel members.

- Q. All conduit entrances through below grade walls and poured-in-place concrete roofs shall be installed through sleeves poured in place or through core drilled opening, unless poured in place.
- R. Sleeves for passage of conduits through poured concrete roofs and below grade walls shall be constructed of heavy wall steel pipe with full circle continuously welded water stop plate. Sleeves shall be sized to accommodate the conduit and link seal combination as specified hereinbefore.
- S. All conduits passing through openings or sleeves in roofs, below grade walls, or floors shall be sealed in place and made watertight with link seal.
- T. All conduit stubs for future use shall be terminated with pipe caps.
- U. Conduit runs installed horizontally overhead shall allow a minimum of 7 feet of headroom, except where installed along structures, piping, equipment, or in other areas where headroom cannot be maintained because of other considerations.
- V. Wherever a conduit emerges from the underside of a slab or roof or enters an area from above and that slab or area or conduit is exposed to the weather, then that conduit shall be provided with a pull box or fitting and filled to a length of 12 inches minimum with conduit sealing compound where the conduit emerges indoors to prevent water from following the conduit interior. The sealing compound shall be as specified hereinbefore under Miscellaneous Fittings and Materials.
- W. Wherever a conduit enters an electrical equipment enclosure from an underground or outdoor location and other locations where indicated on the Drawings, the conduit opening shall be sealed after the wires and/or cables are pulled. One and one half (1½) inch and smaller conduits with more than 20 percent wire fill may be sealed with conduit sealing compound; all other conduits, where required, shall be provided with conduit sealing bushings or compound bushings with ground conductor connectors, as manufactured by O.Z./Gedney or equal. Conduit sealing compound shall be forced into conduits to a minimum depth of 12 inches.
- X. Field bends in conduit shall not be of a lesser radius than that of manufactured elbows of the same trade size and shall show no flattening of the conduit. Conduit bends shall be held to as large a radius as possible for ease in pulling of conductors and to provide a neatly installed appearance. Generally, conduits 1" and smaller shall be bent in the field. Other conduit bends shall conform to the following: 2" and 2½" conduit, 24" radius, 3" and larger with a minimum radius of 36". Except where conduit runs are shown in exact detail on Drawings, the maximum length of straight conduit runs shall be 200 ft. between pull boxes, with 50 ft. deducted for each 90 degree bend and 25 ft. deducted for each 45 degree bend, reduction in length for all other angle bends shall be figured on a similar basis.
- Y. Conduit parallel to or crossing uninsulated hot water or steam pipes shall be separated from same by 12", if parallel, or 7", if crossing. Where hot water or steam pipe lines are insulated, conduit shall clear the insulation surface by 2". Conduit shall not run directly under cold water lines.
- Z. Conduit stub-ups into the bottom of NEMA Type 12, floor mounted enclosures, including motor control centers, shall enter the enclosure through individual holes in the bottom plate or

sheet steel bottom and the openings shall be sealed around each conduit to maintain the enclosure's NEMA Type 12 rating.

- AA. All conduits and sleeves passing through openings in walls above grade or floors shall be sealed in place and made watertight with non-shrink grout or other Owner approved sealant. Non-shrink grout used in floor or wall openings, shall be of the non-metallic type. All openings in fire rated walls and floors shall also be sealed with a fire barrier sealing system capable of maintaining the designed fire rating of the wall or floor and suitable for sealing out smoke and fumes. The fire barrier sealing system shall be capable of passing the ASTM E-814 (UL 1479) fire test and shall be subject to compliance with through penetration firestop systems (XHEZ) listed in Volume II of the UL Fire Resistance Directory; provide products by Hilti Construction Chemicals, Inc.; 3M™ Fire Protection Products; or equal.
- BB. Openings in boxouts through floors or walls or in the bottom of electrical equipment shall be closed using split insulating blocks or non-shrink grout in a manner as approved by the Owner. All unused sleeves shall be capped or plugged at both ends with approved fittings.
- CC. Metallic sleeves containing a ground conductor shall be bonded at each end to the ground conductor.
- DD. The ends of all metallic conduits or elbows shall be cut square, reamed, and threaded.
- EE. The threads of all steel conduit connections concealed in concrete shall be coated at the time of installation with No. B69A45 Zinc clad primary coating, as manufactured by Sherwin William's Corp., Ideal Industries No. 40-630, CRC Chemicals Zinc-It, or equal.
- FF. The threads (metallic) of all corrosive area, outdoor, below grade, and hazardous area equipment connections including conduit, conduit fittings, pull and junction box covers, lighting fixture reflector, guard, and outlet box connections, wiring device boxes, etc. shall be coated with an anti-seize, lubricating, and protective compound prior to final assembly. Coating compound shall be NO-OX-ID "A Special" by Sanchem, Inc., Never-Seez as manufactured by Bostik Div. of Emhart Corp., "Dry Molybdenum Lubricant" No. 40-640 by Ideal Industries, CRC Chemicals Lectra-Shield, or equal.
- GG. Ground and bond metallic raceway systems under provisions of Section 16170.
- HH. All metallic conduits, except those terminated in metal boxes or enclosures without knockouts and secured with double locknuts, integral hubs, or liquidtight hubs, shall be terminated with insulated grounding bushings. Conduits terminated in metal boxes or enclosures without knockouts and secured with double locknuts shall be terminated with an insulating bushing.
- II. All conduits and sleeves, metallic and non-metallic, intended for the passage of wire or cable and not terminated with a fitting, shall be terminated with a bushing or end bell.
- JJ. All connections between metallic conduits and NEMA Type 1 or NEMA Type 12 steel boxes shall be made with double locknuts. All connections between conduits and NEMA Type 3, 3R, 4, and 4X boxes shall be made with watertight connections. Watertight connections shall consist of integral hubs or liquidtight hubs.

- KK. Sealing fittings and all other fittings for conduit in hazardous locations shall be explosion proof, Class I, Division 1, Group D.
- LL. Electrical metal tubing or so called "Thin Wall" conduit and fittings shall not be used.
- MM. Conduit and fittings in areas classified as corrosive, hazardous, and other areas indicated on the Drawings, shall be PVC coated metal conduit and fittings, unless constructed of stainless steel. The installation of such conduit and fittings shall be in strict accordance with the manufacturer's printed instructions and using the manufacturer's recommended tools and touch-up procedures.
- NN. To guarantee proper installation procedures and insure the validation of the manufacturer's warranty, the Contractor must request installation training from the manufacturer, or his appointed representative, prior to installing any PVC Coated Conduit and Fittings on the project. The manufacturer shall provide installation training at no cost to the Contractor. The Contractor shall provide the time and place, preferably at the job site, and the manufacturer shall certify every Contractor's employee completing the installation training.
- OO. All metallic conduit, conduit fittings, supports, hangers, and other exposed metal components installed in areas classified as hazardous and in corrosive areas shall be factory encased in polyvinyl chloride of minimum .040 inch (40 mil) thickness. Where factory PVC coating is not available or where PVC coating would void UL listing or labeling, factory or field coating with a corrosion resistant, epoxy paint shall be provided.
- PP. Flexible conduit may be used only where rigid conduit is impracticable or where indicated on the Drawings.
- QQ. Liquidtight, PVC coated, flexible metal conduit and associated fittings shall be installed as follows:
1. All sections of flexible conduit larger than 1¼ inches in diameter shall be paralleled with a braided copper bonding strap connected between the last section of rigid conduit and the frame of the equipment to ensure a continuous ground.
 2. Liquidtight, PVC coated, flexible metal conduit shall be installed with watertight connectors and in minimum lengths without sharp bends.
- RR. All final conduit connections to motors and other machinery, equipment, and devices which may be subject to movement or vibration shall be made with 15" to 18" of flexible, liquidtight, metallic conduit (unclassified areas only).
- SS. Final conduit connections to motors and other machinery, equipment and devices in hazardous areas which may be subject to movement or vibration shall be made with explosion proof, Class I, Division 1, Group D, flexible conduit couplings.
- TT. Flexible metallic conduit may be used for final connections to lay-in fluorescent lighting fixtures.
- UU. Plastic (PVC) conduit may be used only where indicated on the Drawings.
- VV. Install non-metallic conduit in accordance with manufacturer's instructions.

- WW. Join non-metallic, PVC conduit using cement as recommended by manufacturer. Wipe non-metallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum. The Contractor shall allow 24 hours, minimum, for all solvents to evaporate after cementing the last joint in the raceway system before pulling in any wires or cables.

END OF SECTION

SECTION 16123

WIRE AND CABLE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Building wire.
- B. VFD load wire.
- C. Instrumentation cable.
- D. Communications cables.
- E. Wiring connectors and connections.

1.2 RELATED SECTIONS

- A. Section 16050 – Basic Electrical Materials and Methods.
- B. Section 16110 – Raceways.
- C. Section 16130 – Boxes.
- D. Section 16190 – Supporting Devices.
- E. Section 16195 – Electrical Identification.

1.3 REFERENCES

- A. ANSI/NFPA 70 – National Electrical Code.
- B. Underwriters' Laboratories Standard UL-83.
- C. Underwriters' Laboratories Standard UL-44.
- D. Federal Specification A-A-59544.
- E. ANSI Standard C33.80.
- F. ICEA – Insulated Cable Engineers Association.
- G. ASTM – American Society for Testing and Materials.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide for all wire and cable.
- C. Test Reports: Indicate procedures and values obtained.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency.

1.5 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Wire and cable routing shown on Drawings is approximate. Route wire and cable as required to meet Project Conditions.
- C. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

1.6 COORDINATION

- A. Determine required separation between cable and other work.
- B. Determine cable routing to avoid interference with other work.

PART 2 PRODUCTS

2.1 GENERAL

- A. All wires and cables shall be permanently identified, at intervals not exceeding 3 feet, indicating type, size, voltage rating, and manufacturer's name.
- B. All wires and cables shall be continuous and shall be delivered in reels or in coils. Reels and coils shall be plainly marked for complete identification, including the wire or cable size, the number of conductors, the type of wire or cable, length, weight, thickness and character of the insulation, and the name of the manufacturer.
- C. All coils and reels of wires or cables shall carry original date perforated inspection labels of the Underwriter's laboratories, Inc. showing the number of feet and type of wire contained.

2.2 MANUFACTURERS – BUILDING WIRE

- A. General Cable
- B. Southwire Corporation

2.3 BUILDING WIRE

- A. Description: Single conductor insulated wire.
- B. Conductor: Annealed, uncoated copper. All conductors shall be stranded. ASTM designation B-3.
- C. Conductor Temperature Rating: 90°C in wet locations; 90°C in dry locations.
- D. Insulation Voltage Rating: 600 volts.
- E. Insulation: ANSI/NFPA 70, Type THWN; high temperature polyvinyl chloride with nylon jacket or Type XHHW-2, high temperature cross-linked polyethylene.

2.4 MANUFACTURERS-VFD LOAD WIRE

- A. Southwire Corp.
- B. Belden
- C. General Cable
- D. Okonite Okoguard-Okolon
- E. Prysmian Cables & Systems

2.5 VFD LOAD WIRE

- A. Description: Multi-conductor, ANSI/NFPA 70 Type XHHW-2 or Type RHW-2.
- B. Conductor: Annealed copper. All conductors shall be stranded. ASTM designation B-8, B-33, B-172 or B-174.
- C. Conductor temperature rating: 90°C in wet or dry locations; 130°C emergency overload rating.
- D. Insulation voltage rating: 2000 volts minimum.
- E. Insulation: Type XHHW-2 or Type RHW-2, Cross-linked Polyethylene (XLPE).
- F. Shield: Overall copper tape shield with suitable overlap to prevent separation during installation.
- G. Jacket: Sunlight resistant, black overall PVC in accordance with S-95-658/NEMA WC70.
- H. Installation: If unshielded cable is provided, input line reactors must be provided and installed in VFD.

2.6 MANUFACTURERS – INSTRUMENTATION CABLE

- A. Single Pair Cable:
 - 1. Belden No. 8760
 - 2. Southwire Corporation
 - 3. General Cable/Carol Brand No. C2534.

- B. Multiple Pair Cable:
 - 1. Belden No. 9773 through No. 9777
 - 2. Southwire Corporation
 - 3. General Cable/Carol Brand No. C6047-C6051.

- C. Three Conductor Cable:
 - 1. Belden No. 8770.
 - 2. Southwire Corporation
 - 3. General Cable/Carol Brand No. C2535.

2.7 INSTRUMENTATION CABLE

- A. Description, general:
 - 1. Single pair cable shall be a single twisted pair, No. 18 gauge, stranded conductors with shield, drain wire, and overall jacket.
 - 2. Multiple pair cable shall be two or more individual twisted pair, No. 18 gauge, stranded conductors, each pair with shield and drain wire, and an overall jacket.
 - 3. Three conductor cable shall be three No. 18 gauge, stranded conductors with shield, drain wire, and overall jacket.

- B. Underground and General Use Cables:
 - 1. Conductors: Tinned copper.
 - 2. Insulation voltage rating: 300 volts.
 - 3. Insulation material:
 - a. Single pair cable – polyethylene.
 - b. Multiple pair cable – polyethylene or polypropylene.
 - c. Three conductor cable – polyethylene.
 - 4. Shield material: 100 percent aluminum polyester.
 - 5. Drain wire: Stranded, tinned copper.
 - 6. Jacket: Chrome vinyl (PVC).

- C. Riser and Plenum Use Cables:
 - 1. These cables shall be similar to the underground and general use cables specified above, except that the insulation and the overall jacket materials shall be either FEP or PVDF.

2.8 MANUFACTURERS – COMMUNICATIONS CABLE

- A. RS-232/422, RS-485/DH-485, Ethernet (Category 6), DH+ (Twinaxial), Unshielded twisted pair (UTP), and telephone cables shall be as manufactured by: Belden; Alpha; or Manhattan.

- B. Fiber optic Cables shall be 62.5/125 micron, multi-mode, tight-buffered, breakout type rated for indoor/outdoor use, shall be as manufactured by Optical Cable Corp. Ultra-Fox B-Series, Siecor, or AT&T.

2.9 COMMUNICATIONS CABLE

- A. Wire type communications cables shall meet all applicable standards of EIA/TIA, IEEE, and the NEC.
- B. Fiberoptic cable shall meet all applicable standards of EIA/TIA-4292.AAAA-1989, IEEE, and the NEC.
- C. Riser and Plenum Use Cables:
 - 1. These cables shall be similar to the underground and general use cables specified above, except that the insulation and the overall jacket materials shall be either FEP or PVDF.

2.10 MANUFACTURERS – WIRING CONNECTORS AND ASSOCIATED MATERIALS

- A. Solderless Pressure Connectors:
 - 1. 3M™ Company Model Scotchlok
 - 2. Thomas & Betts Model Sta-Kon
 - 3. Burndy Model Insulug Type TN
- B. Spring Wire Connectors:
 - 1. 3M™ Company Model Scotchlok
 - 2. Ideal Model Wing-Nut
- C. Compression Connectors:
 - 1. 3M™ Company Model Scotchlok
 - 2. Thomas & Betts Model Color-Keyed
 - 3. Burndy Model Hylug
- D. Tap Connectors:
 - 1. Thomas & Betts Model Color-Keyed
 - 2. Burndy Model Crimpit
 - 3. Anderson Model Crimptaps
- E. Watertight, Twist-On Connectors:
 - 1. 3M™ Company Direct Bury Splice Kits
 - 2. King Innovation “DryConn”
 - 3. Ideal Industries, Inc. Twister DB Plus
- F. Watertight, Insulated Connector Blocks:
 - 1. Utilco Type USPA-SS, Type PSA-SS, or Type PED-SS
 - 2. IlSCO Type USPA-SS
- G. Electrical Insulating Tape:
 - 1. 3M™ Company “Scotch” No. 33+

- 2. Plymouth "Premium Black"
- H. High Temperature Tape:
 - 1. 3M™ Company "Scotch" No. 70
 - 2. Plymouth "Plysil"
- I. Fireproofing Tape:
 - 1. 3M™ Company "Scotch" No. 77
 - 2. Plymouth No. 50
- J. Woven Fiberglass Tape:
 - 1. 3M™ Company "Scotch" No. 69
 - 2. Plymouth "Plyglas"
- K. Color Coding Tape:
 - 1. 3M™ Company "Scotch" No. 35
 - 2. Plymouth "Slipknot" No. 45
- L. Insulating and Watertight Sealing Materials:
 - 1. 3M™ Company "Scotchcast" kits
 - 2. Raychem WCS Series heat shrinkable sleeves
 - 3. 3M™ Company 8400 Series cold shrink materials
 - 4. 3M™ Company "Scotchkote" sealant
- M. Metal Clad Cable Fittings:
 - 1. PLM Products JAG Series and TFA Series
- N. Watertight Cord Grip Fittings:
 - 1. Crouse-Hinds CGB-SG Series
 - 2. Appleton Electric Co.
 - 3. Thomas & Betts
- O. Cable or Cord Strain Relief:
 - 1. Hubbell-Kellems
 - 2. Daniel Woodhead Co.
- P. Cable Pulling Lubricant:
 - 1. American Polywater "Dyna-Blue"
 - 2. Ideal "Aqua Gel"
 - 3. Minerallac "Golden Glide"
 - 4. 3M™ Company "GEL"

2.11 WIRING CONNECTORS AND ASSOCIATED MATERIALS

- A. All wiring connectors shall be 75°C rated and suitable for use on copper conductors.
- B. Metal Clad Cable Fittings:
 - 1. Fittings for terminating cables shall conform to NEMA Standards.

2. Individual items shall be the coordinate design of one manufacturer and shall be constructed from quality materials with smooth surfaces; clean, close-fitting threads; and free of sharp edges, burrs, or other defects. Fittings shall be furnished complete with locknuts, bushings, or other required accessories.
3. When installed, the cable clamping element shall provide secure mechanical strength against cable pullout or rotation and provide permanent electrical contact between fitting and metal armor without crushing or distorting either the armor or the cable insulation.
4. Fittings shall be made from steel, with a corrosion resistance coating.
5. The clamping element shall consist of a fixed base with an adjustable clamp containing a contoured lip for close engagement with the armor convolutions. Clamping fasteners shall be accessible from one side and shall be limited to slotted head for screwdriver installation. Clamp range shall not exceed 200 mils per fitting.
6. Gasketed fittings shall provide permanent, watertight seals, unless otherwise noted. All gaskets shall be neoprene. The gasket clamping surfaces shall be smooth and tapered to provide uniform pressure on the gasket.
7. Fittings for jacketed armor cable shall provide a closed neoprene gasket seal to the outer cable jacket, contain a stop to prevent the metal armor from passing through the fitting, and provide a permanent, secure method of grounding the metal armor to the fitting.

C. VFD Cable Fittings:

1. Fittings for terminating at VFDs shall conform to NEMA Standards.
2. VFD fittings shall be designed to provide termination of armor and shield, if provided.
3. When installed, VFD fittings shall include set-screws to limit vibrational loosening.
4. All VFD fittings shall be suitable protected from corrosion and shall be UL listed for use in Type 3R enclosures.
5. All fittings shall form a water-tight seal to the outer jacket of the cable.

D. Cable or cord strain reliefs shall consist of stainless steel wire mesh with support bale. Strain reliefs shall be of the split rod type where required or indicated on the Drawings.

E. Cable Pulling Lubricant:

1. Lubricant shall be UL listed and approved for use on the cable jacket or insulation.
2. Lubricant shall be polymer based and shall dry completely when exposed to air.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that mechanical work likely to damage wire and cable has been completed.

3.2 PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.

3.3 WIRING METHODS

- A. Interior Locations:
1. Wire for general power, light, and control shall be building wire, Type THWN or Type XHHW-2 insulation, in raceway.
 2. Cables for instrumentation signals shall be single or multiple pair Instrumentation Cable.
 3. All wire for connections between Variable Frequency Controllers and associated motors shall be shielded and shall be VFD Load Wire.
- B. Exterior Locations:
1. Wire and cable for general power, light, and control for use in raceways exterior to buildings and in underground raceways shall be building wire Type THWN or Type XHHW-2 insulation.
 2. Cables for instrumentation signals shall be three or more pair Instrumentation Cable.
 3. All wire for connections between Variable Frequency Controllers and associated motors shall be shielded and shall be VFD Load Wire.
- C. Use wiring methods indicated on Drawings.
- D. Color Coding:
The color schedule for the conductor insulation of wire and cable shall conform to the following:
1. Three phase lighting and power, 208Y/120 VAC-Black, Red, Dark Blue, White or Gray, and Green ground.
 2. Three phase lighting and power, 120/240 VAC-Black, Red, Orange (high leg to ground), White or Gray, and Green ground.
 3. Single phase lighting and power, 120/240 VAC-Black, Red, White or Gray, and Green ground.
 4. Three phase lighting and power, 480 VAC-Brown, Orange, Yellow, and Green ground.
 5. Three phase lighting and power, 480Y/277 VAC-Brown, Orange, Yellow, Gray, and Green ground.
 6. DC power – Red with White stripe (+) and Light Blue with White stripe (-).
 7. Single conductor control, AC voltage – Red.
 8. Multi-conductor control cables – ICEA Method 1.
 9. Alarm, annunciator, instrumentation, graphic, and telemetering (if not shielded), AC voltage – Pink.
 10. Alarm, annunciator, instrumentation, graphic, and telemetering (if not shielded), DC voltage – Light Blue.
 11. Intrinsically safe circuits – Purple.
 12. On wire sizes larger than Number 8 AWG and/or where authorized by the Owner, coding may be identified by taping with the appropriate colored self-adhesive vinyl color coding tape.
 13. Grounding conductors shall be continuous green or bare for all systems.
 14. Neutral conductors shall be continuous white or gray for all systems.
- E. The installation of intrinsically safe circuits shall meet all requirements of the NEC.

- F. Wiring Connections:
1. Dry location splices and tap connections shall consist of compression connectors or tap connectors, taped to 150 percent of insulation rating of the conductors.
 2. Final connections to equipment wire leads for No. 8 AWG and smaller wire in dry locations only, except 480 volt motor leads, may be made with spring wire connectors.
 3. Wet and damp location splices and tap connections shall consist of compression connectors or tap connectors with insulating and watertight sealing materials; water tight, twist-on connectors for wire sizes up to three No. 10 AWG; or watertight, insulated connector blocks; providing watertight connections suitable for direct burial.
 4. All conductor terminations at screw terminals shall consist of solderless pressure connectors, except where conductor terminations are included with the equipment being connected.
 5. Insulation of connections in lighting fixture and high temperature equipment shall consist of silicone rubber type high temperature tape with a woven fiberglass tape over-wrap.
 6. Electrical insulating tape (plastic type) shall be used on all splice and tap connections, unless wire manufacturer's recommendations require otherwise.

3.4 INSTALLATION

- A. The installation of communication cables shall meet the requirements of NECA/BICSI 568-2001, Telecommunications.
- B. All wiring shall be run in rigid metal raceway systems or underground conduit systems.
- C. Install products in accordance with manufacturer's instructions.
- D. The minimum size of conductors shall be No. 12 AWG, unless specifically approved and/or shown otherwise on the Drawings.
- E. Use stranded conductors for control circuits, No. 14 AWG minimum, unless shown otherwise on the Drawings.
- F. Multi-conductor underground feeder, branch-circuit, and control cable shall meet the requirements of Article 340 of the National Electrical Code.
- G. Use No. 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 60 feet.
- H. Use No. 8 AWG conductors for 20 ampere, 120 volt branch circuits longer than 100 feet.
- I. Use No. 6 AWG conductors for 20 ampere, 120 volt branch circuits longer than 170 feet.
- J. Use No. 4 AWG conductors for 20 ampere, 120 volt branch circuits longer than 270 feet.
- K. Use No. 3 AWG conductors for 20 ampere, 120 volt branch circuits longer than 420 feet.
- L. Where conductors or cables are to be installed in non-metallic raceway systems, the Contractor shall allow 24 hours, minimum, for all solvents to evaporate after cementing the last joint before pulling wires or cables.

- M. Pull all conductors into raceway at same time. Cable pulling tensions shall not exceed manufacturer's recommended values.
- N. Use suitable wire pulling lubricant for wire, No. 4 AWG and larger, and for all cables. No soap flakes, vegetable oils, clays, or grease shall be permitted in raceways.
- O. Use suitable cable fittings and connectors.
- P. Neatly train and lace wiring inside boxes, equipment, and panelboards. Wires and cables shall be bundled and laced as specified in Section 16190.
- Q. All wires and cables routed through manholes, handholes, cable vaults, large pull boxes, and terminal cabinets shall be looped to provide two to three feet (minimum) of slack within the enclosure, where practical.
- R. Clean conductor surfaces before installing lugs and connectors.
- S. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- T. Wire and cable shall be supported in vertical runs by insulated clamps so that wire or cable weight will not be unduly supported from conductor terminations.
- U. Spade or fork tongue lugs shall not be used, except where approved by the Owner.
- V. Conductor terminations and tap splices within lighting fixture pole/transformer bases shall be suitable for wet or damp locations.
- W. Wires and cables shall, in general, be run continuously, without splicing, from origination to termination. No splices shall be permitted in any feeder circuit, except in outlet, junction, and/or pull boxes, or where specifically noted on the Drawings. Use sufficient length of wire for connecting to equipment without straining. All methods of splicing shall meet cable manufacturer's recommendations. All splices shall be carefully placed in outlet boxes, etc. without crowding. No splicing shall be permitted in signal cables.
- X. Splices and tap connections shall be made in junction boxes only; conduit type fittings shall not be used as junction boxes.
- Y. Wires and cables shall be installed in raceways, as indicated on the Drawings or required, and shall provide a complete and operating system.
- Z. All wires and cables shall be tagged as specified in Section 16195.
- AA. Motor control center feeder circuits and distribution panelboard branch circuits shall each be run in individual raceways from source to motor or other load.
- BB. Vertical lengths of wire and cable shall be supported as required by Article 300.19 of the National Electrical Code. Cable weight shall not be unduly supported from conductor terminations.

- CC. Vertical lengths of exposed cable or cord runs over ten feet long shall be supported with a strain relief.
- DD. Where an exposed run of cable or cord enters a box or enclosure, provide a watertight cord grip fitting suitable for the cable or cord diameter.
- EE. All 120 VAC, single phase loads shall be connected to provide a balanced load on the lighting transformers. All 480 VAC, single phase loads shall be connected to provide a balanced load on the 480 VAC, three phase system.
- FF. Make conductor length for parallel feeders identical on each phase leg.
- GG. Feeders shall be connected for correct phase rotation. Where possible, busses shall be connected to result in the "A" or "X" phase being in the north, east, or top position with the other phases following in sequence. The terminals H1, H2, and H3 of transformers shall be connected to A, B, and C; 1, 2, and 3; or X, Y, and Z conductors, respectively, of incoming feeders.
- HH. Final connections to motors and other machinery, equipment and devices in hazardous areas which may be subject to movement or vibration may consist of a loop of mineral-insulated, metal-sheathed cable (Type MI) with UL listed fittings.

3.5 INTERFACE WITH OTHER PRODUCTS

- A. Identify wire and cable under provisions of Section 16195.
- B. Identify each conductor with its circuit number or other designation indicated on Drawings.

3.6 FIELD QUALITY CONTROL

- A. Perform field inspection and testing under provisions of Sections 01400 and 16960.
- B. Inspect wire and cable for physical damage and proper connection.
- C. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
- D. Verify continuity of each branch circuit conductor.
- E. Verify continuity of each feeder conductor.
- F. All communication cables shall be tested and certified by a qualified third-party after installation in accordance with industry standards, and copies of the certified test results turned over to the Owner.

END OF SECTION

SECTION 16130

BOXES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wall and ceiling outlet boxes.
- B. Pull and junction boxes.
- C. Wireways.

1.2 RELATED SECTIONS

- A. Section 16010 - General Electrical, Instrument, and Control Requirements.
- B. Section 16050 - Basic Electrical Materials and Methods.
- C. Section 16110 - Raceways.
- D. Section 16140 - Wiring Devices.
- E. Section 16160 - Cabinets and Enclosures.
- F. Section 16190 - Supporting Devices.
- G. Section 16195 - Electrical Identification.

1.3 REFERENCES

- A. NECA - Standard of Installation.
- B. NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.
- C. NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- D. NEMA OS 2 - Non-metallic Outlet Boxes, Device Boxes, Covers and Box Supports.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- F. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.

- B. Shop Drawings: Indicate materials, finishes, dimensions, listings, and standards compliance.
- C. Product Data: Provide data for boxes, wireways, and accessories.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.5 SUBMITTALS FOR CLOSEOUT

- A. Section 01700 - Contract Closeout: Submittals for Project closeout.
- B. Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70, National Electrical Code.
- B. Provide Products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to the authority having jurisdiction, as suitable for the purpose specified and indicated.
- C. All boxes shall be sized per Article 314 of the National Electrical Code as a minimum.

PART 2 PRODUCTS

2.1 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
 - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch (13 mm) male fixture studs where required.
 - 2. Concrete Ceiling Boxes: Concrete type.
- B. Non-metallic Outlet Boxes: NEMA OS 2.
- C. Cast Boxes: NEMA FB 1, Type FD, cast ferrous alloy. Provide gasketed cover by box manufacturer. Provide threaded hubs.
- D. Wall Plates for Finished Areas: As specified in Section 16140.
- E. Covers for boxes containing wiring devices shall be as specified in Section 16140.
- F. Outlet boxes for pendant mounted lighting fixtures shall be ball mount, GS or AL Series as manufactured by Appleton Electric Co. or equal. Outlet boxes for pendant mounted fixtures in hazardous areas shall be similar, except explosion proof, Appleton Electric Co. EFHU or equal.

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- G. Outlet boxes in hazardous locations shall be explosion proof, Class I, Division 1, Group D and shall be Type GUA, GUF, and GUJ as manufactured by Crouse-Hinds Co., Appleton, or equal.

2.2 PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- B. Hinged Enclosures: As specified in Section 16160.
- C. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
 - 1. Material: Galvanized cast iron.
 - 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.
- D. Pull and junction boxes for hazardous areas shall be cast iron alloy, explosion proof, Class I, Division 1, Group D as manufactured by Curlee, Appleton, or equal, except boxes for intrinsically safe circuits may be NEMA Type 4 or non-metallic NEMA Type 4X rated.
- E. Single and two gang pull boxes and junction boxes shall be rust proof, cast metal, Type FD boxes with gasketed covers.
- F. Larger boxes and raceways shall be NEMA Type 12, in indoor, above grade locations, or stainless steel NEMA Type 4 or non-metallic NEMA Type 4X with stainless steel hardware in all other locations or where indicated on the Drawings, built of Code gauge steel, with angle iron supports and braces. Cable support racks shall be provided where required. Access shall be by means of removable, gasketed screw covers fastened with machine screws.
- G. NEMA Type 4X boxes shall be of corrosion resistant, high impact strength, fiberglass reinforced polyester material suitable for surface mounting. Barriers shall be provided where indicated on the Drawings or required.
- H. All pull boxes installed below grade within the structures shall be provided with a drain, Crouse-Hinds ECD Universal Series, Appleton, or equal mounted on a bolt-on, gasketed hub or Stahlin Drain Vent on NEMA Type 4X boxes.
- I. In-line pull boxes, where shown on the Drawings, shall be Appleton Type PTC with solid gasket or equal.
- J. Threaded conduit fittings with gasketed covers shall be used for all exposed conduit outlets and boxes.
- K. Conduit bodies and fittings shall be of cast iron, malleable iron, and/or galvanized steel.

2.3 WIREWAYS

- A. Wiring ducts shall be NEMA Type 12 galvanized steel in indoor, above grade locations; non-metallic, NEMA Type 4X in corrosive locations; or stainless steel, NEMA Type 4 in all other locations or where indicated on the Drawings. Metallic wireways shall be 14 gauge

steel raceways and all wireways shall be provided with removable covers held with captive screws. All fittings shall be designed to be used with the ducts to result in an unobstructed system. The ducts and fittings shall be sized as shown on the Drawings. All hardware on stainless steel and non-metallic wiring ducts shall be made of stainless steel.

- B. The wiring ducts shall be as manufactured by Keystone, Hoffman Engineering Co., B-Line, or equal.

2.4 MISCELLANEOUS COMPONENTS

- A. Anti-seize, lubricating, and protective compound shall be Never-Seez as manufactured by Bostik Div. of Emhart Corp., "Dry Molybdenum Lubricant" No. 40-640 by Ideal Industries, CRC Chemicals Lectra-Shield, Crouse-Hinds HTL, Sanchem, Inc. NO-OX-ID "A Special", or equal.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify locations of floor boxes and outlets in all work areas prior to rough-in.

3.2 INSTALLATION

- A. Install boxes in accordance with NECA "Standard of Installation."
- B. Install pull boxes and junction boxes in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
- C. Pull boxes and/or junction boxes shall be used in any conduit run where a splice is required. Pull boxes shall be provided every 200 feet of straight run, every 150 feet after 90 degrees of bends, every 100 feet after 180 degrees of bends, and every 50 feet after 270 degrees of bends. More than 270 degrees worth of bends shall not be installed between pulling points in any conduit run.
- D. Pull boxes, auxiliary pull fittings (slip joints), and cable raceways for the pulling, nesting, or concealment of wires or cables shall be provided where indicated on the Drawings and also where required, though not indicated, as specified above.
- E. Mark or label all boxes as specified in Section 16195.
- F. Set wall mounted boxes at elevations to accommodate mounting heights indicated.
- G. Enough room shall be supplied in boxes for insulating joints, wires, and bushings, and deep boxes shall be installed where required by the type of fixture or outlet called for on the Drawings.

- H. Wire and cable splices and tap connections shall be made in junction boxes only; conduit type fittings shall not be used as junction boxes.
- I. Electrical boxes are shown on Drawings in approximate locations, unless dimensioned. Adjust box location up to 8 feet, if required to accommodate intended purpose.
- J. Orient boxes to accommodate wiring devices oriented as specified in Section 16140.
- K. Maintain headroom and present neat mechanical appearance.
- L. Install boxes to preserve fire resistance rating of partitions and other elements.
- M. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
- N. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- O. At each concealed outlet in slabs or walls in dry locations only, a galvanized, pressed steel box of the knockout type, of not less than No. 12 B & S gauge, shall be placed and securely fastened. The conduits shall be fastened to these boxes with lock nuts, inside and outside, and bushings. All unused knockouts or holes must be left sealed.
- P. Support boxes independently of conduit.
- Q. Use gang box where more than one device is mounted together. Do not use sectional box.
- R. Use cast outlet box in exterior locations and wet locations.
- S. Wall and ceiling mounted pull and junction boxes shall be spaced 1/2 inch minimum out from the wall or ceiling using corrosion resistant channel: Unistrut; Grinnell "Power-Strut", or other approved corrosion resistant spacers.
- T. Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.
- U. The threads of all corrosive area, hazardous area, outdoor, and below grade equipment connections including conduit, conduit fittings, pull and junction box covers, lighting fixture reflector, guard, and outlet box connections, wiring device boxes, etc. shall be coated with an anti-seize, lubricating, and protective compound prior to final assembly.
- V. All metallic, except stainless steel, pull boxes, junction boxes, outlet boxes, and other exposed metal components installed in areas classified as hazardous and in corrosive areas shall be factory encased in polyvinyl chloride of minimum .040 inch (40 mil) thickness. Where factory PVC coating is not available or where PVC coating would void UL listing or labeling, factory or field coating with a corrosion resistant, epoxy paint shall be provided.

3.3 ADJUSTING

- A. Section 01700 - Contract Closeout: Adjusting installed work.

- B. Adjust flush-mounting outlets to make front flush with finished wall material.
- C. Install knockout closures in unused box openings.

3.4 CLEANING

- A. Section 01700 - Contract Closeout: Cleaning installed work.
- B. Clean interior of boxes to remove dust, debris, and other material.
- C. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wall switches.
- B. Receptacles.
- C. Device plates and box covers.

1.2 RELATED SECTIONS

- A. Section 16010 - General Electrical, Instrument, and Control Requirements.
- B. Section 16050 - Basic Electrical Materials and Methods.
- C. Section 16130 - Boxes.

1.3 REFERENCES

- A. NECA - Standard of Installation.
- B. NEMA WD 1 - General Requirements for Wiring Devices.
- C. NEMA WD 6 - Wiring Device -- Dimensional Requirements.
- D. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

- A. Section 01300 - Submittals: Procedures for submittals.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, materials, finishes, and configurations.
- C. Submit manufacturer's installation instructions.

1.5 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Provide Products listed and classified by Underwriters Laboratories, Inc., or other testing firm acceptable to the authority having jurisdiction, as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 WALL SWITCHES

- A. Switches for local control of 120 volt lighting shall be quiet, quick make, slow break design with totally enclosed case, flush type, single pole, toggle switches, 20 ampere capacity at 120/277 volts. Switches shall be UL listed and shall meet NEMA standard WD-1.
- B. Two pole, 3-way, 4-way, and key switches shall have similar ratings.
- C. Lighting switches shall be Hubbell Series HBL1220, Leviton Series 1220, General Electric GE5951, Cooper Wiring Devices, or equal.
- D. Lighting switches installed in corrosive areas shall consist of switches as specified above installed in non-metallic corrosion resistant, FD type boxes with weatherproof, corrosion resistant, flexible silicone rubber, bubble type covers; Hubbell No. HBL1795, Pass & Seymour No. 4517, or equal.

2.2 RECEPTACLES

- A. Duplex receptacles shall be 20 amp, 125 volt, 3 wire, grounding type, Hubbell Cat. No. HBL5362, General Electric GE5362, Cooper Wiring Devices No.5362B, or equal. Covers for general use receptacles shall be Crouse-Hinds Co. No. DS23G, Leviton 5362, Appleton Electric Co., or equal.
- B. Duplex receptacles installed in corrosive areas shall consist of a 20 amp, 125 volt, 3 wire, grounding type, corrosion resistant receptacle; Hubbell Cat. No. HBL53CM62, Leviton 53CM-62, General Electric GE0526C, Cooper Wiring Devices No. 5362CRY, or equal mounted in a non-metallic, corrosion resistant box with a corrosion resistant, weatherproof cover; Carlon, TayMac Corp., or equal.
- C. G.F.C.I. duplex receptacles shall be 20 amp, 125 volt, 3 wire, ground fault circuit interrupter type receptacles with face mounted "test" and "reset" pushbuttons and matching stainless steel cover plate. G.F.C.I. receptacles shall be Hubbell Cat. No. HBL GF-5362-I, Leviton 6898-I, General Electric GFR5362, Cooper Wiring Devices, or equal.
- D. No. 9358, Appleton No. RL5340, or equal.

2.3 WALL AND COVER PLATES

- A. Where switches and receptacles are installed in concealed boxes, they shall be provided with Type 302 stainless steel cover plates.
- B. Where switches are installed surface mounted, they shall be installed in Type FD boxes with mounting lugs and provided with surface mounting covers. Covers shall be weatherproof where required, Crouse-Hinds No. DS181 or equal.
- C. Weatherproof receptacle covers shall be raintight while in use, NEMA Type 3R rated, UL listed and marked for use in Wet Locations with plug-cap inserted, and shall be made of impact resistant, ultraviolet inhibiting polycarbonate; TayMac Corp. with deep cover, Thomas

& Betts WT Series with deep lid, Intermatic Flexi-Guard Series, Carlon E9U In-Use Series, or equal.

- D. Weatherproof covers for single receptacles shall be UL listed and marked for use in Wet Locations, gasketed, cast alloy with spring closed door, Hubbell No. HBL7420, Cooper Wiring Devices, or equal.
- E. Padlockable cover plates for switches and/or receptacles shall be weatherproof, die-cast aluminum with gasket, Killark WCV Series or equal.
- F. For general use switches located in areas designated hazardous, boxes and covers shall be explosion-proof, single gang with rocker arm type operating handles. Covers and boxes shall be catalog No. EFD-175-NL-Q and No. EFK-R12-Q as manufactured by Appleton Electric Co., Crouse-Hinds, or equal.

2.4 MISCELLANEOUS

- A. Anti-seize, lubricating, and protective compound shall be Never-Seez as manufactured by Bostik Div. of Emhart Corp., "Dry Molybdenum Lubricant" No. 40-640 by Ideal Industries, CRC Chemicals Lectra-Shield, Crouse-Hinds HTL, Sanchem, Inc. NO-OX-ID "A Special", or equal.
- B. All metallic, except stainless steel, device boxes, outlet boxes, cover plates, fittings, supports, hangers, and other exposed metal components installed in areas classified as hazardous and in corrosive areas shall be factory encased in polyvinyl chloride of minimum .040 inch (40 mil) thickness. Where factory PVC coating is not available or where PVC coating would void UL listing or labeling, factory or field coating with a corrosion resistant, epoxy paint shall be provided.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions prior to beginning work.
- B. Verify that outlet boxes are installed at proper height.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean debris from outlet boxes.

3.3 INSTALLATION

- A. Install in accordance with NECA "Standard of Installation."
- B. Install devices plumb and level.
- C. Install switches with OFF position down.
- D. Install receptacles with grounding pole on top.
- E. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.
- F. Where more than one switch occurs in the same location, they shall be installed in gang type boxes.
- G. Duplex receptacles, shown on the Drawings outdoors or below grade, shall be mounted in weatherproof boxes and cover plates. The boxes shall be rust proof, cast metal having threaded openings for conduit connections and shall be mounted horizontally on or in the wall.
- H. Receptacles in dry, indoor locations shall be installed in surface mounting, Type FD boxes with mounting lugs.
- I. The threads of all hazardous area, outdoor, and below grade equipment connections including conduit, conduit fittings, outlet box connections, wiring device boxes, cover plate screws, etc. shall be coated with an anti-seize, lubricating, and protective compound prior to final assembly.
- J. See Section 16195 for nameplate, circuit number marker, wire marker, etc. requirements.

3.4 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations of outlet boxes provided under Section 16130 to obtain mounting heights specified or indicated on the Drawings.

3.5 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify that each receptacle device is energized.
- D. Test each receptacle device for proper polarity.
- E. Test each GFCI receptacle device for proper operation.

3.6 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

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3.7 CLEANING

- A. Section 01700 - Contract Closeout: Cleaning installed work.
- B. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

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SECTION 16160
CABINETS AND ENCLOSURES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Hinged cover enclosures.
- B. Cabinets.
- C. Terminal boxes.
- D. Accessories.

1.2 RELATED SECTIONS

- A. Section 16010 - General Electrical, Instrument, and Control Requirements.
- B. Section 16050 - Basic Electrical Materials and Methods.
- C. Section 16110 - Raceways.
- D. Section 16130 - Boxes.
- E. Section 16190 - Supporting Devices.
- F. Section 16195 - Electrical Identification.

1.3 REFERENCES

- A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- B. NEMA ICS 4 - Terminal Blocks for Industrial Control Equipment and Systems.
- C. ANSI/NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide manufacturer's standard data for enclosures and cabinets.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

- D. Certified shop drawings and diagrams shall be furnished by the Contractor and delivered to the Owner for approval as follows:
 - 1. General dimensions and outline drawings showing the principal dimensions of the equipment and the location and size of electrical conduit connections.
 - 2. Detailed drawings, descriptive data, and other data sheets showing design information which verified that the equipment meets the technical requirements of the Specifications.

1.5 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction, as suitable for purpose specified and shown.

1.6 EXTRA MATERIALS

- A. Furnish under provisions of Section 01700.
- B. Provide three (3) of each cabinet key.

PART 2 PRODUCTS

2.1 CABINETS AND HINGED COVER ENCLOSURES

- A. Manufacturers: Manufacturers and model numbers of cabinets, enclosures, and associated components shall be as follows:
 - 1. Cabinets and Enclosures: Hoffman Engineering Co., Saginaw Controls, Stahlin, or Hammond.
 - 2. Anti-condensation Heaters: Saginaw Control & Engineering No. SCE-AHC50 or equal.
 - 3. Terminal Blocks: Allen-Bradley No. 1492-CA1, CA3, or -CD8.
 - 4. Substitutions: Items of equal function and performance are acceptable, if in conformance with all sections of this Specification.
- B. Cabinets and enclosures in dry locations shall be dust and oil tight, rated NEMA Type 12, and of 14 gauge (minimum) painted sheet steel construction or comparable non-metallic.
- C. Cabinets and enclosures in wet locations shall be watertight, rated NEMA Type 4, and of 14 gauge (minimum) painted sheet steel construction or comparable non-metallic.
- D. Cabinets and enclosures in corrosive areas shall be water, dust, and sleet tight, rated NEMA Type 4X, and of stainless steel construction or comparable non-metallic.
- E. Doors shall be equipped with a padlockable latch or padlock hasp and shall be provided with one (1) padlock with three keys.
- F. The top, sides, and doors of outdoor cabinets and enclosures shall be insulated with a 2-inch thick layer of extruded polystyrene material.

- G. The doors shall be gasketed.
- H. Provide an internal, mild steel sub-plate for mounting of internal components.
- I. Provide and install two (2) minimum, 120 volt, anti-condensation heaters within each outdoor cabinet or enclosures. The heaters shall be of the self-limiting type, 50 watts, 120 VAC.
- J. Cabinets and enclosures shall be provided with full-length door hinges. Hinges shall be stainless steel and the doors shall have a one point latch.
- K. All interior cabinet or enclosure surfaces, except fittings, shall be painted with two coats of primer and two coats of white, high gloss, baked epoxy enamel paint. The exterior shall be painted with one coat of primer, two coats of ANSI 61 gray paint, and a final coat of clear polyurethane.
- L. Terminal blocks shall be provided for all wiring entering cabinets and enclosures from external devices. Provide 10 percent spare terminals, in addition to those required.
- M. Terminal boxes shall be similar to cabinets and enclosures, except they shall have screw covers in lieu of hinged and latched doors.

2.2 EXPLOSION PROOF CABINETS, ENCLOSURES, AND TERMINAL BOXES

- A. Explosion proof cabinets, enclosures, and terminal boxes shall be cast iron or cast aluminum with external mounting ears for surface mounting, internal mounting plate, hinged cover with stainless steel bolts and NEMA Type 4 seal, explosion proof, Class I, Division 1, Group D with bossed, drilled, and tapped conduit entrances as required for conduit and fitting connections as indicated on the Drawings. Explosion proof boxes shall be factory or field coated with a corrosion resistant, epoxy paint.
- B. Terminal blocks for power conductor connections shall be power distribution blocks for connection of copper wire with individual, set screw type connectors for each terminated conductor, Gould Shawmut 66000 Series, Marathon 143 Series, or equal. Terminal blocks for control conductor connections shall be of the screw terminal type, number of blocks as required, Allen-Bradley No. 1492-CA1 with associated mounting devices, Square D, or equal.
- C. Provide an insulating barrier between the power and the control terminations.
- D. Explosion proof terminal boxes shall be Hope Electrical Products Co. H6000 Type, Crouse-Hinds Style C Series EJB, or equal.

2.3 ENCLOSURE ACCESSORIES

- A. All hardware on the exterior of NEMA Type 4 and NEMA Type 4X enclosures, including hinge pins, screws, bolts, nuts, washers, etc., shall be made of 300 series stainless steel.
- B. Combination drain and breather shall be Crouse-Hinds ECD Combination Series, Appleton, or equal. Combination drain and breather shall be Stahlin Drain Vent or equal on NEMA Type 4X enclosures.

- C. Anti-seize, lubricating, and protective compound shall be Never-Seez as manufactured by Bostik Div. of Emhart Corp., "Dry Molybdenum Lubricant" No. 40-640 by Ideal Industries,

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CRC Chemicals Lectra-Shield, Crouse-Hinds HTL, Sanchem, Inc. NO-OX-ID "A Special", or equal.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify installation conditions under provisions of Section 01039.
- B. Verify that surfaces are ready to receive work.

3.2 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner.
- C. Install cabinet fronts plumb.
- D. All equipment installed in hazardous areas shall be provided in explosion proof enclosures, except equipment listed as intrinsically safe may be provided in NEMA Type 4 or non-metallic NEMA Type 4X enclosures. All explosion proof enclosures shall be factory or field coated with a corrosion resistant finish.
- E. NEMA Type 4 and Type 4X enclosures in other than corrosive areas shall be equipped with a combination drain and breather. The drain shall be mounted on a bolt-on, gasketed hub.
- F. All internal cabinet and enclosure components shall be mounted on the sub-plate positioned for easy access, convenient wiring, and for easy removal.
- G. Convenience receptacle mounted within cabinets and enclosures shall be mounted in a handy box with a cover plate.
- H. See Section 16110, Raceways for conduit entrance to cabinets and enclosures requirements.
- I. Mark or label all boxes, cabinets, and enclosures as specified in Section 16195.
- J. The threads of all corrosive area, hazardous area, outdoor, and below grade equipment connections including conduit, conduit fittings, pull and junction box covers, cable fittings, etc. shall be coated with an anti-seize, lubricating, and protective compound prior to final assembly.
- K. Cabinets and enclosures shall be mounted to walls, columns, machine frames, etc., with 1/2" separation from same, and all necessary spacers, brackets, structural pieces, inserts, anchors, and bolts shall be provided.

END OF SECTION

SECTION 16170
GROUNDING AND BONDING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Grounding electrodes and conductors.
- B. Equipment grounding conductors.
- C. Bonding.

1.2 RELATED SECTIONS

- A. Section 03300 - Concrete Work.
- B. Section 16010 - General Electrical, Instrument, and Control Requirements.
- C. Section 16050 - Basic Electrical Materials and Methods.
- D. Section 16960 – Electrical Testing and Equipment.

1.3 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.

1.4 GROUNDING ELECTRODE SYSTEM

- A. Metal underground utility piping.
- B. Metal frame of the building.
- C. Ground loops, risers, and conductors.
- D. Rod electrodes.
- E. Ground mat.

1.5 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 5 ohms.
- B. In the event that the ground resistance is not 5 ohms or less, additional rods or longer rods shall be installed or the soil treated to reduce its resistance by approved practices. All ground resistance measurements shall be made using the fall-of-potential method only and test reports shall be provided as specified under Section 16960, Electrical Testing and Equipment.

1.6 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide data for grounding electrodes and connections.
- C. Test Reports: Indicate facility's overall resistance to ground.
- D. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation and installation of exothermic connectors.

1.7 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01700.
- B. Accurately record actual locations of grounding electrodes.

1.8 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction, as suitable for purpose specified and shown.

PART 2 PRODUCTS

2.1 ROD ELECTRODES

- A. Ground rods shall be 3/4" diameter by 10 feet long and shall have copper jackets and steel cores. The rods shall be as manufactured by Blackburn/Eritech, Erico Electrical Products, Harger, or equal.

2.2 MECHANICAL CONNECTORS

- A. All compression connectors, lugs, etc., used in grounding circuits in any location shall have bolts, nuts, etc., of silicon bronze alloy equal to "Everdur" metal. Grounding connections, clamps, etc., shall be as manufactured by Burndy Engineering Company, Thomas and Betts Company, Delta-Star Electric Company, Harger, or equal.
- B. Fittings for bonding a grounding conductor to metallic conduit shall be Thomas and Betts Series 3900BU or equal. Fittings for bonding a grounding conductor to its own conduit shall be Burndy Engineering Company GAR-BU Series, Thomas and Betts Series 3900, Harger, or equal.
- C. Where connections to ground rods or ground mats must be disconnected for testing, the fittings shall be Burndy Engineering Co. Type GD, GG, GAR; Thomas and Betts Co. Series 3902BU; Harger; or equal.

2.3 EXOTHERMIC CONNECTIONS

- A. Connections to steel, between conductors, and for water stops shall consist of exothermic welding similar and equal to Burndy Engineering Company's "Thermoweld", Erico Products, Inc. "Cadweld Kits", Thomas & Betts Corp. "Furseweld", or Harger.

2.4 CONDUCTORS

- A. Grounding conductors, loops, and risers shall be bare, stranded, soft-drawn copper and shall be of the sizes indicated on Drawings.
- B. All bonding jumpers shall be copper and of a cross-sectional area at least equal to their corresponding grounding conductors.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Install rod electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground. Rod electrodes shall be driven into undisturbed earth or engineered backfill only.
- C. Provide bonding to meet Regulatory Requirements.
- D. The non-current carrying parts of all electrical equipment installed under this Contract, including but not limited to raceways, raceway supports, and equipment enclosures, shall be bonded by means of bare copper cable or copper strap to the grounding system as shown on the Drawings and specified hereinafter.
- E. All underground, metallic, service piping (water, gas, etc.) shall be solidly connected to the building grounding system with a No. 4/0 AWG grounding conductor (minimum) at the piping's entrance to the building.
- F. All exposed, including painted or coated, structural and architectural metal shall be bonded to the grounding system or rigidly secured to and in good electrical contact with grounded metal.
- G. All grounding cables, bus, etc., in locations where subject to mechanical damage, shall be protected by rigid metal conduit, steel guards, non-metallic conduit, or other suitable shield. In all cases, where conduit or other metallic encasement of grounding conductors is required, the conductor shall be permanently and effectively grounded to the enclosure at both ends of its length. This requirement applies to all such enclosures regardless of their length.

- H. Where grounding conductors pass through floor slabs, building walls, etc., and are not encased in the concrete pour, sleeves of rigid metal conduit or non-metallic conduit of the required size, shape, and length shall be provided with both ends of the sleeve sealed with duct seal after installation of the grounding conductor.
- I. Where grounding conductors pass through a concrete pour (encased), from underground to the interior of a structure, an exothermic water stop shall be provided on the grounding conductor within the pour.
- J. Where attached to equipment, conduits, cabinets, etc., suitable approved solderless lugs, compression connectors, or clamps shall be used. No soldered connections shall be used on grounding circuits at any point.
- K. Where a grounding cable is to be bonded to structural or architectural metal, the exact location of each bond shall be approved by the Owner. The location of such grounding connections shall be at points where they will not be subject to mechanical damage and, if possible, shall be accessible for inspection.
- L. Where welding to steel is prohibited, the grounding conductor shall be bolted directly to the steel as approved by the Owner. The contact surfaces of all bolted connections shall be thoroughly cleaned and coated with Alcoa No. 2 Electrical Joint Compound or equal.
- M. Taps and splices in grounding cables and connections to ground rods shall be made by an exothermic weld process.
- N. All metal ducts, conduits, starters, panels, switches, etc., which are not rigidly secured to and in good electrical contact with the grounded structural metal frame of the building or grounded conduit system, or which are subject to excessive vibration and loosened ground contacts, shall be securely bonded to grounded building steel or to the grounded conduit system by means of stranded copper jumpers. This jumper shall have a circular-mil cross section of not less than 50 percent of that of the largest conductor entering the enclosure being grounded, with a minimum size of No. 8 AWG stranded copper being used in any jumper.
- O. Conduits which run to boxes or cabinets having concentric or eccentric knockouts which partially perforate the metal around the conduit and impair the electrical connection to ground shall be provided with approved bonding jumpers. Jumpers shall consist of a stranded, braided copper wire at least No. 8 AWG with solderless indent type lugs. Jumper shall be connected from a grounding type locknut or bushing on the conduit inside the box to a stud or silicon bronze alloy bolt in the cabinet frame.
- P. All metal support racks for electrical equipment and enclosures shall be securely bonded to grounded building steel or the grounding system with a No. 2 AWG grounding conductor.
- Q. A copper ground conductor shall be carried for each power, lighting at 120 volts and higher, and receptacle circuit with the circuit conductors. The ground conductor shall have the same type insulation as the circuit conductors and shall be green in color through No. 10 AWG and bare copper wire for larger sizes.

- R. Switchgear, motor control center, distribution panelboard, and automatic transfer switch grounding shall consist of ground connections to feeder conduits, ground busses, etc. as required or as indicated on the Drawings.
- S. Splices in wire or cable ground leads shall not be permitted.

3.3 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- B. Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.

END OF SECTION

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SECTION 16190
SUPPORTING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Conduit and equipment supports.
- B. Anchors and fasteners.

1.2 REFERENCES

- A. NECA - National Electrical Contractors Association.
- B. ANSI/NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide manufacturer's catalog data for fastening systems.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction, as suitable for purpose specified and shown.

PART 2 PRODUCTS

2.1 PRODUCT REQUIREMENTS

- A. Materials and Finishes: Provide adequate corrosion resistance.
- B. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.
- C. Conduit and equipment supports and hangers shall be made of galvanized structural steel, with welded or bolted joints. Conduit and equipment supports and hangers shall be fabricated from "Unistrut" Series P1000 galvanized channels and fittings, as manufactured by the

- Unistrut Products Company, Superstrut A-1200 Series, Grinnell "Power-Strut" PS-200, or equal.
- D. All conduit and equipment supports, hangers, beam clamps (no "C" clamps shall be allowed), and other similar devices made of steel shall be hot dipped galvanized or sherardized after fabrication. All hanger rods, U-bolts, bolts, nuts, and other threaded support components shall be electro-galvanized (per ASTM-B633 Type III SC1) or sherardized. Field cuts and all welds shall be coated with an approved cold or hot galvanizing compound: Z.R.C., CRC Chemicals Zinc-It, or equal. All hanger rods shall be 3/8 inch diameter minimum. All such hardware shall be factory encased with polyvinyl chloride (PVC) of minimum .040 inch (40 mil) thickness where indicated on the Drawings and where indicated elsewhere in Division 16. All touch-up required in the field shall be in strict accordance with the manufacturer's printed instructions.
- E. Concrete inserts shall be of the continuous channel or spot type. The channel type shall be No. 12 gauge steel with integral anchors, Super Strut No. C-302, Kindorf No. D-990, or equal. Spot inserts shall be Super Strut No. 452, Kindorf No. D-255, or equal.
- F. Threaded anchors for use in concrete shall be self-drilling type expansion anchors made of case hardened and drawn carburized steel. The anchors and expander plugs shall be furnished with a rustproof finish. The expansion anchors shall be concrete fasteners as manufactured by the ITW "Red Head", Ideal Industries Co., or equal.
- G. Threaded anchors for heavy loads (i.e.: panels, transformers, disconnect switches) supported from masonry or precast concrete panels shall be epoxy based adhesive anchors with threaded rod and screen tube. Adhesives shall match the application, as recommended by the anchor manufacturer. Threaded rods, nuts, and washers shall be furnished with a rustproof finish. Adhesive anchors shall be Hilti Type HIT or equal.
- H. Anchors for light loads (i.e.: conduit clamps, outlet boxes, small pull and junction boxes) supported from masonry or precast concrete panels shall be lead type or plastic expansion anchors with corrosion resistant screws.
- I. Threaded rods, nuts, washers, screws, and bolts for anchors used in areas classified as hazardous and in corrosive areas shall be made of 316 stainless steel. Also expansion anchors for light loads used in masonry or precast concrete panels in these areas shall be plastic only.
- J. Anti-seize, lubricating, and protective compound shall be Never-Seez as manufactured by Bostik Div. of Emhart Corp., "Dry Molybdenum Lubricant" No. 40-640 by Ideal Industries, CRC Chemicals Lectra-Shield, Crouse-Hinds HTL, Sanchem, Inc. NO-OX-ID "A Special", or equal.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions. Tighten all bolted connections to manufacturer's recommended torque values with compensation for lubricated threads (anti-seize, lubricating and protective compound applied) to avoid over-torquing.
- B. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
- C. Do not anchor supports from pipes, ducts, mechanical equipment, or conduit.
- D. Do not use spring steel clips and clamps.
- E. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- F. Obtain permission from Architect/Engineer before drilling or cutting structural members.
- G. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- H. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- I. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch (25 mm) off wall.
- J. All electrical enclosures, including raceways, boxes, panelboards, motor control equipment, etc., shall be securely attached to the building or structure walls by means of concrete inserts or expansion anchors, unless indicated as rack mounted on the Drawings or of free standing design. Unless otherwise indicated, all electrical enclosures, except conduit and outlet boxes, shall be spaced at least 1/2 inch from the wall or ceiling with Unistrut, Grinnell "Power-Strut", or equal.
- K. The use of wood plugs for anchoring raceways, cabinets, enclosures, or equipment to concrete or masonry will not be permitted.
- L. The Contractor shall provide and install, where required, the additional steel to adequately support all conduits, boxes, and all other electrical equipment.
- M. All wires and cables shall be laced when entering or leaving pull or junction boxes and at each termination. Wires and cables shall be laced so that the wires of the individual circuits are laced together by circuit. All wiring entering and exiting electrical enclosures shall be bundled into groups. Power, lighting, control, alarm, annunciator, and instrumentation wiring shall be bundled and laced as specified herein.
- N. The threads of all corrosive area, hazardous area, outdoor, and below grade support connections shall be coated with an anti-seize, lubricating, and protective compound prior to final assembly.

- O. All metallic, except stainless steel, supports, hangers, and other exposed metal components installed in areas classified as hazardous and in corrosive areas shall be factory encased in polyvinyl chloride of minimum .040 inch (40 mil) thickness as specified under Section 16110, Raceways. Where factory PVC coating is not available, factory or field coating with a corrosion resistant, epoxy paint shall be provided.

END OF SECTION

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Nameplates and labels.
- B. Wire and cable markers.
- C. Conduit markers.

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide catalog data for nameplates, labels, signs, diagrams, and markers.
- C. Submit schedule of proposed equipment labels.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation and installation of Product.

1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.

PART 2 PRODUCTS

2.1 NAMEPLATES AND LABELS

- A. The nameplates shall be 1 1/4" high by 3 1/2" wide (minimum), except pushbutton and selector switch stations and other enclosures where space is limited may have smaller plates of suitable size, and shall be attached to the equipment by means of corrosion resistant screws. Nameplates may be attached to equipment located in dry, interior areas by means of pressure sensitive, firm acrylic adhesive tape, 3M "Scotch" No. 468 or equal. The plates shall be white laminated plastic with engraved black letters approximately 3/32" thick with beveled edges. Engraved letters shall be 1/8" high (minimum), block type.
- B. Circuit number markers shall consist of self adhesive vinyl cloth or polyvinyl fluoride film markers with 1/8" high (minimum), black lettering on a yellow background, W. H. Brady Co.

3410 Series, Ideal Industries 44-500 Series and 44-600 Series, or equal. Circuit number markers may also consist of computer or typewriter generated, vinyl cloth, permanent, non-smearing, self-adhesive markers such as Brady Datab, BradyMarker XC Plus, 3M Scotchcode SCS or STS, or equal. Circuit number markers for panelboard circuit breakers may be the manufacturer's standard.

- C. Arc flash and shock hazard warning labels shall consist of self-adhesive vinyl or polyester signs, 3-1/2" by 5" minimum, with "⚠ WARNING" header (black letters on orange field), "Arc Flash and Shock Hazard" subheader and write-in spaces for the following information:

___ Flash Hazard Boundary
___ cal/cm² Flash Hazard at 18 inches
___ PPE _____
___ Shock Hazard When Cover is _____
___ Limited Approach
___ Restricted Approach _____
Equipment Name: _____

Warning labels shall be in compliance with NEC 110.16 requirements. Warning labels shall be Brady Signmark No. 89220, Lab Safety Supply Co. No. 68691, Seton Style No. M0548, or equal.

2.2 WIRE MARKERS

- A. Wire and cable tags for use in large pull boxes, large junction boxes shall be made of minimum 1/8" thick white laminated plastic, 1-1/4" by 3-1/2", with black engraved identification in letters 3/64" deep by 3/16" high minimum. Tags shall be drilled at each end and secured twice to each cable by 3/32" minimum diameter polyethylene cord. Tags shall be engraved with the circuit number, equipment served, and associated nominal voltage level.
- B. Wire and cable number tags for use in pull or junction boxes and at termination points shall be computer or typewriter generated, vinyl cloth, permanent, non-smearing, self-adhesive markers such as Brady Datab, Brady Marker XC Plus, or 3M Scotchcode. Pre-printed, vinyl cloth, plastic coated, self-adhesive, tape markers as manufactured by W. H. Brady Co. or 3M Company shall also be acceptable.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive nameplates and labels.

3.2 INSTALLATION

- A. Nameplates shall be installed on the doors or covers of all panels, panelboards, starters, contactors, transfer switches, relays, control devices, signaling devices, and all other electrical equipment furnished under this Contract, except remote mounted pushbutton and selector switch stations, mounted adjacent to identified and associated disconnect switches or other control devices, need not be identified as described herein.

- B. Nameplate engraving for equipment and devices associated with motor starters, panelboard, or control panel circuits shall match the engraving indicated in schedules on the Drawings, except nameplates for spare units and devices shall be furnished blank. All other nameplates shall be engraved as follows and shall be included on nameplate schedules submitted to the Owner for approval:
 - 1. First Line - Process description, equipment served, or area served (if applicable).
 - 2. Second Line - Equipment or device description.
 - 3. Third Line - Equipment or device designation number and power source circuit number.
 - 4. Abbreviations shall be used only where full wording will not fit. See the Drawings for nameplate details.
- C. All devices and equipment powered from lighting panelboards shall be marked with the appropriate circuit number(s). Lighting circuits shall be identified on switch cover plates, receptacles on cover plates, and other devices on enclosure door or on associated disconnect switch door or cover.
- D. The entire raceway system for intrinsically safe circuits shall be labeled "Intrinsic Safety Wiring" per National Electrical Code Article 504.80(B).
- E. All pull boxes shall be marked with the type of system within them, i.e.: 480V power, alarm, 120V control, etc.
- F. All wires and cables within control panels, motor starters, terminal boxes, etc. shall be tagged at each termination.
- G. The wires and cables of each circuit in pull boxes and junction boxes larger than 12" by 12" by 8" shall be bundled together, neatly arranged, and clearly identified with a tag secured with polyethylene cabling twine indicating circuit number, equipment served, and nominal voltage level.
- H. A system shall be developed and submitted to prevent duplication of wire numbers for all wiring external to equipment. Equipment numbers or designations may be used as prefixes. Interconnecting diagrams shall clearly show wire numbers, originating terminal numbers, and destination terminal numbers.
- I. All enclosures, panels, boxes, and devices containing electrical components and circuits with exposed, energized parts when the door is open, shall have an arc flash and shock hazard warning label affixed to the door. All label blank fields shall be filled in with permanent markers according to the results of the Short Circuit, Flash Hazard, and Protective Devices Coordination Analyses, in Section 16050.

END OF SECTION

SECTION 16441

ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fusible disconnect switches.
- B. Non-fusible disconnect switches.

1.2 RELATED SECTIONS

- A. Section 16010 - General Electrical, Instrument, and Control Requirements.
- B. Section 16050 - Basic Electrical Materials and Methods.
- C. Section 16130 - Boxes.
- D. Section 16160 - Cabinets and Enclosures.
- E. Section 16170 - Grounding and Bonding.
- F. Section 16190 - Supporting Devices.
- G. Section 16195 - Electrical Identification.
- H. Section 16477 - Fuses.

1.3 REFERENCES

- A. NEMA KS 1 - Enclosed Switches.
- B. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide switch ratings and enclosure dimensions.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with NECA Standard of Installation.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction, as suitable for purpose specified and shown.

PART 2 PRODUCTS

2.1 DISCONNECT SWITCHES

- A. 600 volt rated, NEMA Type 12 and NEMA Type 4X enclosed disconnect switches shall be Eaton Cutler-Hammer, Square D by Schneider Electric, or General Electric.
- B. 600 volt rated, explosion proof disconnect switches shall be Eaton Crouse-Hinds, Emerson Appleton Electric Co. Type EDS, or Hubbell-Killark.
- C. Fused disconnect switches for 120 VAC, 208 VAC, or 240 VAC, single phase loads and fractional horsepower motors shall be fusible, 30 ampere, 2 pole, 2 wire, 240 VAC rated switches in a NEMA Type 12 enclosure, unless indicated otherwise on the Drawings, similar to Eaton Cutler-Hammer No. DH-221NDK, Square D No. H221AWK, or equal. Disconnect switches for 120 VAC loads shall have a fuse eliminator in the neutral phase leg.
- D. Non-fused disconnect switches for 120 VAC, 240 VAC, or 208 VAC single phase loads and fractional horsepower motors shall be similar to 2 pole manual motor starters, except without overloads, Square D Class 2510, Eaton Cutler-Hammer, or equal. Enclosures for switches installed in hazardous areas shall be explosion proof, suitable for Class I, Division 1 use, Appleton Electric Co. Type GUSC or equal. Enclosures for switches installed in corrosive areas shall be non-metallic, corrosion resistant, FD type boxes with weatherproof, corrosion resistant, flexible silicone rubber, bubble type covers; Pass & Seymour No. 4517, Hubbell No. HBLDS3, or equal. Enclosures for all other areas shall be FD type boxes with padlock type covers.
- E. Auxiliary interlocks shall be provided where shown on the Drawings.
- F. All disconnect switches shall have provisions for padlocking in either the "On" or "Off" positions and all terminals or lugs shall be 75°C rated for copper conductors. Fused switches shall utilize Class R fuses.
- G. Combination drain and breather shall be Crouse-Hinds ECD Combination Series, Appleton, or equal.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install disconnect switches where indicated.
- B. Install fuses in fusible disconnect switches.
- C. Provide heavy duty, 3 pole, 600 volt, non-fused or fused disconnect switches through 100 amperes at locations indicated or as required.
- D. NEMA Type 4 and Type 4X enclosures in other than corrosive areas shall be equipped with a combination drain and breather. The drain shall be mounted on a bolt-on, gasketed hub.
- E. See Section 16195 for nameplate, circuit number marker, labeling, etc. requirements.
- F. Arc-flash and shock hazard warning labels shall be provided on the door of each switch enclosure and shall be marked as specified in Section 16195.

END OF SECTION

SECTION 16461

DRY TYPE TRANSFORMERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Dry type two winding transformers.

1.2 RELATED SECTIONS

- A. Section 16110 - Raceways.
- B. Section 16170 - Grounding and Bonding.
- C. Section 16190 - Supporting Devices.
- D. Section 16195 - Electrical Identification.

1.3 REFERENCES

- A. NEMA ST 1 - Specialty Transformers.
- B. NEMA ST 20 - Dry Type Transformers for General Applications.
- C. NFPA 70 - National Electrical Code.
- D. ANSI-C57.
- E. 10 CFR Part 431 Energy Conservation Program: Energy Conservation Standards for Distribution Transformers.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.
- C. Test Reports: Indicate loss data, efficiency at 25, 50, 75, and 100 percent rated load, and sound level.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
- E. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with NECA Standard of Installation.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction, as suitable for purpose specified and shown.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect, and handle products to site under provisions of Section 01600.
- B. Deliver transformers individually wrapped for protection and mounted on shipping skids.
- C. Accept transformers on site. Inspect for damage.
- D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- E. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 DRY TYPE TRANSFORMERS

- A. The transformers shall be indoor or outdoor, self air-cooled, dry type, designed in full accordance with the latest revisions of ANSI C57.
- B. Transformers shall have taps as follows:
 - 1. Single and three phase, 15 kVA and below: two 5% FCBN
 - 2. Single phase, 25 kVA and above: two 2-1/2% FCAN and four 2-1/2% FCBN
 - 3. Three phase, 30 kVA and above: two 2-1/2% FCAN and four 2-1/2% FCBN
- C. The transformers shall be rated as shown on the Drawings. Single phase units shall have voltage ratings of 480 volt primary and 120/240 volt secondary, 60 Hertz alternating current and three phase units shall have 480 volt primary and 208Y/120 volt secondary as shown on the Drawings.
- D. The transformers shall be designed and tested to have a BIL of not less than 10 kV on the primary and secondary.
- E. Single and three phase units less than 30 kVA shall be rated 115°C type rise with insulation system designed for a total temperature of 185°C. 30 kVA and larger units shall be rated 150°C rise with insulation system designed for a total temperature of 220°C.

- F. The transformer cases shall be equipped with knockouts for conduit and shall be prepared for painting by "Bonderizing" or other process. A primer coat followed by two finish coats shall then be applied. The color of the finish coat shall be ANSI No. 61 Gray or as otherwise approved by the Owner. Transformers installed outdoors shall be provided with weather shields.
- G. Appropriate terminals shall be provided to permit proper termination of copper conductors in the event that transformer windings are aluminum. All terminals or lugs shall be 75°C rated for copper conductors.
- H. Transformers shall meet the requirements of the most current version of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment". Refer to Transformer Efficiency Table.
- I. The dry type transformers shall be Eaton, Sola/Hevi-Duty, Micron, or Square D by Schneider Electric.

2.2 Transformer Efficiency Table

Single-Phase		Three-Phase	
kVA	Efficiency %	kVA	Efficiency %
15	97.70%	15	97.89%
25	98.00%	30	98.23%
37.5	98.20%	45	98.40%
50	98.30%	75	98.60%
75	98.50%	112.5	98.74%
100	98.60%	150	98.83%
167	98.70%	225	98.94%
250	98.80%	300	99.02%
333	98.90%	500	99.14%
		750	99.23%
		1000	99.28%

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify installation conditions.
- B. Verify that surfaces are suitable for installing transformer supports.

3.2 PREPARATION

- A. Provide concrete pad for floor mounted transformers under provisions of Section 03300.

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3.3 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions and NECA 409-2002, Dry Type Transformers.
- B. Set transformer plumb and level.
- C. Use flexible conduit, under the provisions of Section 16110, 2 ft. (0.6 M) minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- D. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.
- E. Provide grounding and bonding in accordance with Section 16170.
- F. The transformer windings shall be single phase or three phase, as shown on the Drawings. The neutral connection of the secondary winding shall be terminated with an approved solderless lug and shall be solidly connected to ground.
- G. The transformers shall be given shop tests to verify the rating and potential tests in conformity with applicable IEEE and NEMA Standards. Three certified copies of all test reports shall be furnished the Owner for approval prior to shipment together with a description of how the test was made.
- H. See Section 16195 for marking and labeling requirements.

3.4 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 16960.
- B. Check for damage and tight connections prior to energizing transformer.
- C. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION

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SECTION 16470

PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Distribution panelboards.
- B. Lighting panelboards.

1.2 RELATED SECTIONS

- A. Section 16010 – General Electrical, Instrument, and Control Requirements.
- B. Section 16050 – Basic Electrical Materials and Methods.
- C. Section 16190 – Supporting Devices.
- D. Section 16195 – Electrical Identification: Engraved nameplates.

1.3 REFERENCES

- A. NECA (National Electrical Contractors Association) “Standard of Installation.”
- B. NEMA AB 1 – Molded Case Circuit Breakers.
- C. NEMA PB 1 – Panelboards.
- D. NEMA PB 1.1 – Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or less.
- E. NFPA 70 – National Electrical Code.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement and sizes.
- C. Manufacturer’s Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01700.

- B. Record actual locations of Products; indicate actual branch circuit arrangement.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01700.
- B. Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with NECA Standard of Installation.

1.8 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction, as suitable for purpose specified and shown.

PART 2 PRODUCTS

2.1 DISTRIBUTION PANELBOARDS

- A. The distribution panelboards shall be NEMA Type 12 rated and shall have overall doors. Boxes shall be made of galvanized steel and the fronts and doors shall be made of painted steel. The fronts shall be designed for surface or floor mounting as shown on the Drawings. The doors shall be equipped with flush hinges and locks. All locks shall be keyed alike and six keys shall be furnished and delivered to the Owner. Glazed directory frames and cards designating the branch circuits shall be mounted on the inside of each of the cabinet doors. The door and panel trim shall be given one primer coat and not less than two coats of ANSI 61 paint. The panelboards shall have ground buses for terminating ground conductors.
- B. The panelboards shall be of the circuit breaker type and shall be designed for 600 volt, 3 phase, 3 wire, 60 Hertz alternating current service. The panelboards shall be equipped with main lugs and bus and branch circuits of sizes as shown on the Drawings. Feed through lugs, sized the same as the main lugs, shall be included where space limitations require additional panelboard section(s) to accommodate the scheduled branch circuit breakers. All panelboard bus work shall be copper and all terminals or lugs shall be 75°C rated for copper conductors.
- C. The circuit breakers shall be of the molded case, bolt-in-place type with thermal magnetic trip and shall be 600 volt, quick-make, quick-break with indicating trip and 25,000 A. interrupting capacity minimum at 480 volts. Breaker handles shall clearly indicate the “on”, “off”, and “tripped” positions. Each circuit breaker shall be provided with a padlockable handle lock hasp.
- D. Distribution panelboards shall be provided with 20% spare breakers and/or bussed space.

- E. The panelboards shall be Eaton Cutler-Hammer Pow-R-Line 4B, Square D by Schneider Electric I-Line Type HCM, or General Electric Type CCB.

2.2 LIGHTING PANELBOARDS

- A. Lighting panelboards shall be factory assembled for 208Y/120 volt, three phase, 4 wire, solid neutral service or 120/240 volt, single phase, 3 wire, solid neutral service, as shown on the Drawings, with ground bus. Panelboards shall have main circuit breakers or main lugs only with single, two, or three pole circuits as indicated on the Drawings.
- B. All panelboard bus work shall be copper and all terminals or lugs shall be 75°C rated for copper conductors.
- C. Provide locking devices for 20% of the circuit breakers in each panelboard.
- D. The panelboard boxes shall be surface or flush mounted, as indicated on the Drawings, of code gauge commercial hot galvanized sheet steel, and with angle iron supports provided for ease in alignment of panel interior. The door and panel trim shall be finished with one prime coat and at least one finish coat of gray enamel. Doors shall be furnished with flush type combination catch and lock. All lighting panel locks shall be keyed alike and six (6) keys shall be furnished and delivered to the Owner. Panelboards shall have a NEMA Type 12 rating.
- E. The panelboards shall be listed by UL with an integrated interrupting capacity of 22,000 RMS symmetrical amperes at 240 VAC, minimum.
- F. Interiors shall be furnished with circuit breakers of the molded case, bolt-in-place type using single pole or common trip, two or three pole as indicated on the Drawings. Circuit breakers shall be of the molded case type with thermal magnetic trip and breaker handles indicating "on" – "off" and "trip" positions. Ground fault circuit interrupter (GFCI) type breakers shall be provided where indicated on the Drawings. Breakers shall have 22,000 ampere interrupting capacity and shall be approved for "switching duty." Circuits shall be sequence phased. Panelboards shall be 20" w. x 5-3/4" d. minimum with an overall door, Panelboards shall be Eaton Cutler-Hammer Pow-R-Line 1, Square D by Schneider Electric NQOD, or General Electric Type AQ.
- G. The panels shall be provided with a directory on the inside of the door. Card shall be protected by a permanently transparent plastic window.
- H. Lighting panelboards shall be provided with 20% spare breakers and/or bussed space.

2.3 MODIFICATIONS TO EXISTING PANELBOARDS

- A. Where indicated on the Drawings, provide modifications to existing panelboards as required. The panelboards shall be modified by the addition of new devices, connections to existing devices, and/or disconnection from existing devices.
- B. Circuit breakers for addition to existing panelboards shall be the panelboard manufacturer's compatible replacement parts and shall match the panelboards existing breaker interrupting ratings. Breaker trip ratings and number of poles shall be as indicated on the Drawings.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install panelboards in accordance with NEMA PB 1.1 and NECA 407-2015, Panelboards.
- B. Install panelboards plumb. Install recessed panelboards flush with wall finishes. Provide supports in accordance with Section 16190.
- C. Wall Mounting Height: 6 ft. (2 M) to top of panelboard; install panelboards taller than 6 ft. (2 M) with bottom no more than 4 inches (10 cm) above floor.
- D. Provide filler plates for unused spaces in panelboards.
- E. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.
- F. All panelboard circuit breakers or switches shall have a circuit number marker on or adjacent to the breaker or switch.
- G. Provide engraved plastic nameplates and circuit number markers under the provisions of Section 16195.
- H. Arc-flash and shock hazard warning labels shall be provided on the door of each panelboard and shall be marked as specified in Section 16195.

3.2 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Sections 01400 and 16960.
- B. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.
- C. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers and lugs.

END OF SECTION

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SECTION 16477

FUSES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fuses.

1.2 RELATED SECTIONS

- A. Section 16010 - General Electrical, Instrument, and Control Requirements.
- B. Section 16050 - Basic Electrical Materials and Methods.

1.3 REFERENCES

- A. NFPA 70 - National Electric Code.
- B. NEMA FU 1 - Low Voltage Cartridge Fuses.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide data sheets showing electrical characteristics including time-current curves and fuse let-through values for fault current available.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01700.
- B. Submit series ratings for fuse and circuit breaker combinations, where applicable.
- C. Provide type II documents for motor starters.
- D. Record actual fuse sizes.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction, as suitable for purpose specified and shown.

1.7 EXTRA MATERIALS

- A. Furnish under provisions of Section 01700.
- B. Provide ten (10) spare fuses of each size and type, rated 600 VAC and lower, installed.
- C. For additional spare parts requirements, see Section 16010.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Bussmann
- B. Mersen
- C. Edison
- D. Littelfuse

2.2 FUSE REQUIREMENTS

- A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.
- B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.
- C. Fuses shall be dual element or current limiting type, Class R, or as otherwise required for installation in existing equipment or in the equipment furnished, and as shown on the Drawings. Fuses shall provide type II protection for motor circuits.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install fuses in accordance with manufacturer's instructions.
- B. Install fuse with label oriented such that manufacturer, type, and size are easily read.
- C. All fuse holders shall be provided with fuses.
- D. The Contractor shall replace all blown fuses and the quantities specified above shall be turned over to the Owner at the time of completion.
- E. Spare fuses shall, be packed and boxed for storing with each box labeled with fuse rating, class, etc.

END OF SECTION

SECTION 16481

ENCLOSED MOTOR CONTROLLERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Manual motor starters.
- B. Magnetic motor starters.
- C. Combination magnetic motor starters.

1.2 RELATED SECTIONS

- A. Section 16010 - General Electrical, Instrument, and Control Requirements.
- B. Section 16050 - Basic Electrical Materials and Methods.
- C. Section 16190 - Supporting Devices.
- D. Section 16195 - Electrical Identification: Engraved nameplates.
- E. Section 16477 - Fuses.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code.
- B. UL 198C - High-Interrupting Capacity Fuses; Current Limiting Type.
- C. UL 198E - Class R Fuses.
- D. NECA "Standard of Installation," published by National Electrical Contractors Association.
- E. NEMA AB 1 - Molded Case Circuit Breakers.
- F. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
- G. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
- H. NEMA KS 1 - Enclosed Switches.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.

- B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
- C. Test Reports: Indicate field test and inspection procedures and test results.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
- E. The equipment shall not be released for manufacture prior to approval of, and coordination with, the Short Circuit, Flash Hazard, and Protective Devices Coordination Analyses specified in Section 16050.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with NECA Standard of Installation.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction, as suitable for purpose specified and shown.

1.7 SPARE PARTS

- A. Furnish under provisions of Section 01700.
- B. Furnish one (1) set of replaceable contacts for each type of relay and each size of contactor or starter installed in motor controllers furnished under this Contract.
- C. Furnish three (3) push-to-test indicating light assemblies to match those installed in motor controllers furnished under this Contract.
- D. Furnish ten (10) indicating light lamps.
- E. Furnish two (2) indicating light lens' of each color installed in motor controllers furnished under this Contract.
- F. Furnish one (1) control switch assembly of each type installed in motor controllers furnished under this Contract.
- G. For additional spare parts requirements, see Section 16010.

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PART 2 PRODUCTS

2.1 MAGNETIC MOTOR STARTERS

- A. Full voltage starters shall be combination motor circuit protector type, unless otherwise noted, and motor starter complete with three pole, ambient compensating overload relays, and control circuit transformer. Starters shall be equipped with a spare auxiliary contact in addition to those shown on the Drawings, shall be minimum NEMA Size 1, and shall have 120 volt coils.
- B. Reduced voltage starters shall be of the autotransformer type comprised of NEMA sized contactors in combination with a motor circuit protector and with three pole, ambient compensating overload relays, and other devices similar to those specified for full voltage starters above. The autotransformer shall have taps for starting the load at 65% of rated voltage and shall have a built-in thermal switch for overtemperature protection. Control (auxiliary) relays, latch relays, time delay relays, and other control devices shall be provided, as indicated on the Drawings and shall be as specified hereinafter.
- C. Two speed starters shall consist of fast and slow contactors in combination with a motor circuit protector and with three pole, ambient compensating overload relays for each winding, and other devices similar to those specified for full voltage starters above. The contactors shall each be equipped with a spare auxiliary contact in addition to those shown on the Drawings, shall be NEMA Size 1 minimum, and shall have 120 volt coils. Control transformer, control (auxiliary) relays, selector switches, indicating lights, and other control devices shall be provided as indicated on the Drawings and shall be as specified hereinafter.
- D. Where indicated on the Drawings, starters shall include ground fault protective devices. The ground fault protective devices shall include a current transformer, a ground fault relay, and test circuit and shall be suitable for interrupting the starter control circuit. Ground fault monitoring and test devices shall be mounted on the starter door and shall include a trip indicator, a manual reset button, and a test button. Testing with or without tripping shall be possible.
- E. Starters shall be electrically operated and held type, three pole assemblies with coil, contact assemblies, and integral overload protection. Coil shall be warranted for life.
- F. Motor overload protection shall consist of a thermal overload relay of the three pole, ambient compensating, manual reset, and solid state type.
- G. Solid state motor overload protection shall include time-current characteristics and shall be field selectable or adjustable. Accuracy shall be within 2%. Solid state overloads shall monitor three phase motor current utilizing three current sensors. The trip Class 10, 20, and 30 shall be field selectable and provide 10, 20, or 30 second delay at six times the full load running protection respectively. Solid state overloads shall be manually reset with the ability to convert to automatic reset in the field. Overload relay shall have two outputs: 1) an alarm indicator indicating motor is running in overload and, 2) an overload trip indicator.
- H. Oiltight pushbutton and selector switches and push-to-test, transformer type, indicating lights shall be provided as indicated on the Drawings. Control devices mounted on doors of NEMA Type 4 enclosed starters shall be NEMA Type 4 rated. All starters with manual reset overload relays shall have an external overload reset pushbutton mounted on the enclosure door.

- I. Starters for 120 volt, single phase motors shall be combination, non-fused disconnect switch and two pole motor starter complete with single pole overload relay.
- J. Starters shall have NEMA Type 12 enclosures where mounted indoors, stainless steel NEMA Type 4 enclosures where outdoors or below grade indoors, or non-metallic NEMA Type 4X enclosures in corrosive locations, unless otherwise shown on the Drawings. All hardware on the exterior of NEMA Type 4 enclosures, including hinge pins, screws, bolts, nuts, washers, etc., shall be made of stainless steel.
- K. Control circuit transformers shall have fused primary windings and 120 volt, fused, and grounded secondary windings. Control circuit transformers shall have extra capacity where required to carry connected loads.
- L. Fuses shall be as specified under Section 16477.
- M. All unit line and load terminals or lugs shall be 75°C rated for copper conductors. Terminal boards or blocks shall be provided for all external connections and shall be readily accessible from the front of the starter enclosure. All wiring to external devices shall be terminated at the terminal blocks, excluding incoming power feeders and motor leads. All wires and terminals shall be tagged to agree with schematic and wiring diagrams.
- N. Each starter shall have a reduced size, approved, "as-built," schematic wiring diagram, in ladder diagram format, inside each unit, indicating all internal components and wiring terminal strip connections, all 480 V. power wiring, all 120 V. control and power wiring, all instrument wiring, and all external components and wiring (shown dotted). Wiring diagrams shall have a plasticized coating to protect them from dirt, heat, and normal wear and tear.
- O. Motor starters shall be Eaton Cutler-Hammer A200 Series, Allen-Bradley Bulletin 500 Line, or Square D.

2.2 MANUAL MOTOR STARTERS

- A. The manual motor starters shall be of the toggle switch, "On-Off" type, and shall be horsepower rated with thermal overloads. The starters shall be single pole and the enclosures shall be NEMA Type 1 or, where indicated on the Drawings, explosion proof or NEMA Type 4. Where shown on the Drawings they shall be provided with a pilot lamp and/or a "Hand-Off-Automatic" selector switch (NEMA Type 1 enclosed only).
- B. The starters shall be Type MS as manufactured by Eaton Cutler-Hammer, Square D by Schneider Electric Type 2510, or equal.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Provide motor starters for each motor not provided for by others or controlled by starters in motor control centers.

- B. The Contractor shall verify all motor horsepowers prior to procurement of starters and installation of motor wiring.
- C. Install enclosed controllers where indicated, in accordance with manufacturer's instructions.
- D. Install enclosed controllers plumb. Provide supports in accordance with Section 16190.
- E. Height: 5 ft. (1.6 M) to operating handle or as indicated on the Drawings.
- F. Install fuses in fusible switches.
- G. Select and install overload heater elements or set solid state overload relays in motor controllers to match installed motor characteristics.
- H. All device settings shall be provided and installed by the device supplier, based on equipment operating and protection requirements. Submit for Owner approval prior to implementation. All as-built settings shall be included in supplied O&M manuals.
- I. Provide engraved plastic nameplates under the provisions of Section 16195.
- J. Provide neatly typed label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.
- K. NEMA Type 4 and Type 4X enclosures in other than corrosive areas shall be equipped with a combination drain and breather. The drain shall be mounted on a bolt-on, gasketed hub. Combination drain and breather shall be Crouse-Hinds ECD Combination Series, Appleton, or equal.
- L. Arc flash and shock hazard warning labels shall be provided on the door of each contactor and starter enclosure and shall be marked as specified in Section 16195.

3.2 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Sections 01400 and 16960.
- B. Inspect and test each enclosed controller to NEMA ICS 2.

END OF SECTION

SECTION 16483

VARIABLE FREQUENCY CONTROLLERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Six (6) pulse variable frequency controllers.

1.2 RELATED SECTIONS

- A. Section 03300 – Concrete Work: Concrete Pads and Foundations.
- B. Section 16010 – General Electrical Instrument, and Control Requirements.
- C. Section 16050 – Basic Electrical Materials and Methods.
- D. Section 16170 – Grounding and Bonding.
- E. Section 16195 – Electrical Identification.
- F. Section 16960 – Electrical Testing and Equipment.
- G. Section 16970 – Calibration and Start-up of Systems.
- H. Section 16980 – Demonstration and Training.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code.
- B. NEMA ICS 3.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Shop Drawings: Include front and side views of enclosures with overall dimensions and weights shown; conduit entrance and exit locations and requirements; and nameplate legends.
- C. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, schematic diagram, component list and enclosure details.
- D. Test Reports: Indicate field test and inspection procedures and test results.

- E. Manufacturer's Test Reports: The manufacturer shall provide three (3) certified copies of factory test reports.
- F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- G. Manufacturer's Field Reports: Indicate start-up inspection findings.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01700.
- B. Operation Date: Include instructions for starting and operating controllers and describe operating limits that may result in hazardous or unsafe conditions.
- C. Maintenance Data: Include routine preventive maintenance schedule.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum ten (10) years documented experience, and with service facilities within 100 miles of project.

1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Section 01600.
- B. Accept controllers on site in original packing. Inspect for damage.
- C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

1.9 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings.

1.10 EXTRA MATERIALS

- A. Furnish under provisions of Section 01700.

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- B. Furnish one (1) set of replaceable contacts for each type of relay installed in variable frequency controllers furnished under this Contract.
- C. Furnish one (1) control switch assembly of each type installed in variable frequency controllers furnished under this Contract.
- D. Furnish two (2) of each air filter element installed.
- E. Furnish one (1) of each size cooling fan installed.
- F. For additional spare parts requirements, see Section 16010 and Section 16477.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Allen-Bradley
- B. Square D/Schneider Electric
- C. ABB
- D. Eaton Cutler-Hammer
- E. No Substitutions.

2.2 VARIABLE FREQUENCY CONTROLLERS (VFD) DESCRIPTION

- A. General
 - 1. The VFD shall be solid state, with a Pulse Width Modulated (PWM) output. The VFD shall utilize sensor-less vector AC to AC converter utilizing the latest Insulated Gate Bipolar Transistor (IGBT) technology. The VFD shall also provide an optional mode for V/Hz operation.
 - 2. The variable frequency drive (VFD) motor controller shall convert 460 Volt, three-phase, 60 Hertz utility power to adjustable voltage (0 - 460V) and frequency (0 - 60 Hz) three-phase, AC power for stepless motor speed control with a capability of 10:1 speed range. All general options and modifications shall mount within the adjustable frequency controller enclosure.
 - 3. The VFD shall be rated 460V as shown on the Drawings. The VFD shall provide a microprocessor-based adjustment of three phase motors. The variable frequency and voltage output shall provide constant volts per hertz excitation for the motor up to 60 hertz. The controllers shall be rated as shown on the Drawings. As a minimum the full load output current of the drive shall be equal to the equivalent motor horsepower as listed by National Electric Code Table 430.150.
 - 4. The VFDs shall be capable of operating any NEMA B squirrel cage induction motor, regardless of manufacturer, with a load rating within the capacity of the VFD's.
 - 5. The VFD shall have a "Hand-Off-Auto" selector switch mounted on the door and connected to allow control from the keypad and local or remote mounted pushbutton

- switches, when in the “Hand” position and control from remote contacts, when in the “Auto” position.
6. The VFDs shall utilize a Voltage Source Pulse Width Modulated (PWM) technique for producing adjustable frequency speed control.
 7. The VFD shall include output short circuit protection for line-to-line and line-to-ground faults.
 8. The harmonics introduced by the variable frequency controllers at the point of common coupling (PCC) shall meet the requirements of IEEE 519-2014 for General Systems. For purposes of this Specification the PCC shall be the utility feeder to the facility. Short circuit amperes at this point and total demand load are noted on the system one line drawing.
 9. The harmonic distortion shall meet the distortion levels shown in Table 10.3 of IEEE 519-2014 for I_{sc}/I_L . Use the following source data in order to perform the calculations:
 - a. Voltage: 480, 3 phase, 4 wire
 - b. kVA: 750
 - c. Impedance: 5.75%
 - d. Total maximum demand load: 550 amps.

B. Specific Design Requirements for Six Pulse Type VFD Units (for units less than 100 Hp).

1. VFD shall be sinusoidal input type. VFD control shall include transient voltage suppression to allow reliable operation on a typical industrial power distribution system.
2. VFD shall be of the six (6) pulse rectifier and pulse width modulated (PWM) design, and shall provide microprocessor based, software programmable protection and operation of a three-phase motor.
3. The VFD shall be wall mounted in a NEMA Type 12 enclosure when not mounted in within another enclosure.
4. Provide an input circuit breaker, interlocked with the enclosure door, with through-the-door handle to provide positive disconnect of incoming AC power. The circuit breaker shall be rated for 42,000 AIC minimum.
5. Provide an integrally mounted or separately enclosed input line reactor, sized for the VFD load and designed to limit harmonics on the power distribution circuit.

C. HARMONIC MITIGATION

1. The VFD shall limit harmonic distortion reflected onto the utility system to a voltage and current level as defined by IEEE 519 for general systems applications, by utilizing the standard 5% DC link choke with input surge protection or a 3% line reactor.
2. The VFD shall employ a technology that will limit Harmonic levels to less than 38% at the input terminal of the VFD. If line reactors are used, they shall not exceed 5% to avoid excessive voltage drop.
3. Documentation must be submitted verifying Harmonic levels at or below 38% at the terminals of the VFD prior to approval.
4. Drives supplied as part of the equipment shall also meet and be required to verify Harmonic levels of less than 38% at the input terminals.

2.3 DESIGN OF VFD UNIT

- A. Employ microprocessor based inverter logic, isolated from power circuit.

- B. Employ switching power supply operating off DC link.
- C. Design for ability to operate controller with motor disconnected from output.
- D. Design to attempt five (5) automatic restarts, following fault conditions, before lock-out.
- E. Speed droop shall reduce the speed of the drive on transient overload.
- F. Critical speed avoidance circuit.
- G. A door mounted keypad with operational and diagnostic messages display unit (2-line, 24-character min., LCD display).
- H. "Self-Test" software program to verify proper keypad operation.
- I. Minimum efficiency of 96 percent at full load and speed and 80% at 50% speed and load.
- J. Displacement power factor between 1.0 and 0.95 lagging, over entire range of operating speed and load.
- K. Output voltage regulator to maintain correct output v/hz ratio despite incoming voltage variations.
- L. Password security to protect drive parameters from unauthorized personnel.
- M. All program settings shall be stored in non-volatile memory to prevent loss during power outages.
- N. AC input line current limiting fuses rated 100,000 AIC or circuit breaker rated 65,000 AIC for fault current protection of AC and DC converter section. If fuses are used, fuses must be fast acting and current limiting.
- O. The controller shall be designed and constructed to operate within the following service conditions:
 - 1. Elevation: 0 to 3300 feet.
 - 2. Ambient Temperature Range: 0°C to 40°C.
 - 3. Atmosphere: Non-Condensing relative humidity 0 to 95%.
 - 4. AC Line Voltage Variation: -5% to +10%.
 - 5. AC Line Frequency Variation: ± 3 Hertz.
 - 6. AC power: 480V, 3 phase, 60 hz power supply.

2.4 PRODUCT FEATURES

- A. Display: Provide integral display to indicate output voltage, output frequency in hertz, output current, speed demand in percentage, control mode: (manual/automatic), total three-phase kW, time, date, drive temperature, elapsed time meter, motor RPM.
- B. Status indicators for protective functions: Separate indicators for overcurrent, over voltage, under voltage, over frequency, phase loss, over temperature, ground fault, etc.

- C. Volts Per Hertz Adjustment: plus or minus ten percent.
- D. Current Limit Adjustment: 60 to 110 percent of rated.
- E. Acceleration Rate Adjustment: 0.5 to 3000 seconds.
- F. Deceleration Rate Adjustment: 1 to 30 seconds.
- G. Provide “Start” and “Stop” pushbuttons, “Local – Remote” selector switch, and manual speed control on the VFD control panel.
- H. Input signals: 4-20 MADC and start/stop signal (120 VAC) from PLC.
- I. Safety Interlocks: Provide terminals for remote contacts to inhibit starting under both manual and auto mode.
- J. Input line fuses or breaker for circuit protection.
- K. Real Time Clock: Controller shall include a real time clock function for a day and time stamp of fault occurrence, start time stamp, stop time stamp, and operating hours.
- L. Fault History: Controller shall record and time-stamp faults.
- M. An “Emergency Stop” circuit shall utilize dynamic braking.
- N. Motor control circuit shall incorporate control, protective relay, and alarm circuits as required to coordinate with the ancillary, protective, and alarm devices supplied by the pump or motor manufacturer.
- O. Input signals to VFD:
 - 1. (6) Discrete Digital Inputs
 - 2. (2) 4 to 20mA Analog Inputs
- P. Output signals from VFD:
 - 1. Analog output signal 4-20 MADC proportional to output frequency.
 - 2. Run relay with two isolated sets of form C contacts.
 - 3. Dry contacts (2 amps at 120 VAC) to indicate VFD ready, running, and fail on a remote panel. Running contacts shall indicate that the motor is running, whether powered from the VFD or the bypass contactor. Fail contacts shall indicate VFD trouble or motor shutdown due to protective circuits.
- Q. Laminated plastic nameplate engraved with the drive’s designation, as indicated on the Drawings.
- R. Each controller shall have a reduced size, approved, “as-built,” schematic wiring diagram, in ladder diagram format, inside each unit, indicating all internal components and wiring terminal strip connections, all 480 V. power wiring, all 120 V. control and power wiring, all instrument wiring, and all external components and wiring (shown dotted). Wiring diagrams shall have a plasticized coating to protect them from dirt, heat, and normal wear and tear.

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- S. VFD shall include digital communications.
 - 1. The VFD shall communicate over the Ethernet/IP protocol.
 - 2. The VFD shall include an RJ-45 port for communication.

2.5 FABRICATION

- A. The VFD systems shall be fabricated by the same VFD manufacturer, to assure a properly coordinated system.
- B. All VFD components shall be factory mounted and wired. Free-standing enclosures shall be suitable for mounting on a concrete housekeeping pad.
- C. Enclosures shall be not less than 16-gauge steel with surface thoroughly cleaned and phosphatized prior to painting. They shall be primed with a corrosion-resisting coating. Cabinet finish paint to be ANSI 61 Gray.
- D. Overall dimensions of fabricated VFD shall fit within the available space indicated on the Drawings.

PART 3 EXECUTION

3.1 FACTORY TESTING

- A. Factory testing shall be performed per the manufacturer's standard testing procedure.
- B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.2 WARRANTY

- A. Manufacturer shall provide a three (3) year warranty beginning from the date of start-up and acceptance of the equipment. The warranty shall cover all parts, labor, and travel time.

3.3 EXAMINATION

- A. Verify conditions.
- B. Verify that surface is suitable for controller installation.
- C. Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.

3.4 INSTALLATION

- A. Install controller where indicated, in accordance with manufacturer's written instructions and NEMA ICS 3.1.
- B. Tighten accessible connections and mechanical fasteners after placing controller.
- C. Install fuses.

- D. Select and install overload heater elements in motor controllers to match installed motor characteristics.
- E. Provide labels and engraved plastic nameplates under the provisions of Section 16195.
- F. Provide neatly typed label inside each controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.
- G. Arc flash and shock hazard warning labels shall be provided on the door of each vertical section and shall be marked as specified in Section 16195.
- H. Install the motor leads in grounded metal conduit or provide shielded cable motor leads with the shield grounded.

3.5 FIELD QUALITY CONTROL

- A. Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and start-up of the equipment specified under this Section. The manufacturer's representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained herein.
- B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative.
 - 1. Inspection and final adjustments.
 - 2. Operational and functional checks of VFDs and spare parts.
 - 3. Record and provide the harmonic line distortion, including the total harmonic distortion and total demand distortion for all drives.
- C. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.
- D. The Contractor shall provide three (3) copies of the manufacturer's field start-up report.

3.6 MANUFACTURER'S FIELD SERVICES

- A. Prepare and start systems under provisions of Sections 01400 and 16970.

3.7 ADJUSTING

- A. Adjust drive parameters to assure proper operation of system. Obtain performance requirements from installer of driven loads.

3.8 CLEANING

- A. Touch up scratched or marred surfaces to match original finish.

3.9 DEMONSTRATION

- A. Provide systems demonstration under provisions of Section 16980.

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- B. Demonstrate operation of controllers in automatic and manual modes.

3.10 TRAINING

- A. The Contractor shall provide a training session for up to three (3) Owner's Representatives for one (1) normal working days at a job site location determined by the Owner.
- B. The training session shall be conducted by a manufacturer's qualified representative.
- C. The training program shall consist of instructions on the proper maintenance and operation of the equipment.

END OF SECTION

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SECTION 16960

ELECTRICAL TESTING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Division 16 testing requirements.
- B. Sample forms.

1.2 RELATED SECTIONS

- A. Section 01400 - Quality Control: Manufacturer's Field Reports.
- B. Section 16010 - General Electrical, Instrument, and Control Requirements.
- C. Section 16050 - Basic Electrical Materials and Methods.
- D. Section 16970 – Calibration and Start-up of Systems.

1.3 REFERENCES

- A. All testing methods shall be in conformance with the following documents:
 - 1. National Electrical Code, latest approved edition.
 - 2. Any and all Federal, State, and/or local codes, ordinances, or regulations.
 - 3. NETA Acceptance and Maintenance Specifications and Safety Guidelines.
- B. All equipment shall be tested in conformity with all requirements, as a minimum, of applicable standards of IEEE, NEMA, ISA, ANSI, ICEA, UL, and OSHA, except as modified herein.

1.4 SUBMITTALS

- A. Submit on Products under provisions of Section 01300.
- B. Product Data: Indicate electrical characteristics and specifications; including layout of switches, buttons, displays, dimensions, weights, and external power requirements; and, list cables, connections and all available accessories.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit test results under provisions of Section 01700.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01700.

- B. Operation Data: Include bound copies of operating and programming instructions.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and use of product(s).

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years documented experience.
- B. Cable testing shall be performed by technicians certified in accordance with ANSI/NETA ETT-2000 Standards for the Certification of Electrical Testing Technicians. Technicians performing these electrical tests and inspections shall be trained and experienced concerning the apparatus and systems being evaluated. These individuals shall be capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved. They must evaluate the test data and make an informed judgment on the continued serviceability or non-serviceability of the specific equipment. Each on-site crew leader shall hold a current certification, Level III or higher, in electrical testing.

1.8 REGULATORY REQUIREMENTS

- A. Furnish Products listed and classified by Underwriters Laboratories, Inc. (UL), Factory Mutual (FM), and/or Canadian Standards Association (CSA), as specifically indicated, and as acceptable to authority having jurisdiction, as suitable for purpose specified and indicated.
- B. All test instruments and devices shall be in conformance with all applicable standards and requirements of ISA, IEEE, ANSI, NEMA, and Underwriters' Laboratories. NIST – traceable certificates of calibration shall be provided with each instrument/device.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Section 01600.
- B. Accept products on site in factory containers. Inspect for damage. Turn over to Owner immediately.

PART 2 PRODUCTS

None.

PART 3 EXECUTION

3.1 TESTING

- A. The Contractor shall perform all testing necessary to ensure that the work performed under the Contract is satisfactory and in conformity with the requirements of the Contract Documents.

- B. All testing shall be performed prior to start-up of equipment or systems as specified under Section 16970.
- C. All tests shall be witnessed by the Owner's Representative and four (4) copies of all field tests, as specified herein and in other Sections, shall be submitted to the Owner. Twenty-four (24) hours (minimum) written notice shall be given the Owner prior to performing the tests. Such tests shall be scheduled at a time agreed upon by the Owner and the Contractor.
- D. Testing shall include, but shall not be limited to, the following tests:
1. Insulation resistance to ground of all conductors and equipment.
 2. Continuity, connections, and integrity of the facility's entire grounding system.
 3. Continuity, polarity, phase sequence, and connection of all current carrying conductors and equipment.
 4. Power Cable Tests shall be made as follows:
 - a. All new 480 volt feeder and branch circuit wires and cables shall be given a dielectric absorption test. The dielectric absorption tests shall be made in accordance with NETA Acceptance and Maintenance Specifications and NETA Safety Guidelines.
 - b. Wire insulation tests shall be made with a 1000 volt megger on 480 volt power distribution cables and/or wires. Each test shall be continued for a time sufficient to charge the cable or wire.
 5. The following information shall be included in a test report on each cable:
 - a. Complete identification of cable, including approximate length.
 - b. Approximate average cable temperature.
 - c. Megger readings versus time data, including converted values.
 6. In order to be acceptable, the cable must withstand the specified high voltage without breakdown or have satisfactory megger readings.
- E. All improper connections, or materials, and equipment not adapted to the purpose for which it is intended, or material, or equipment found to be faulty while performing the tests, shall be corrected; and any changes or repairs necessary to put the work in satisfactory condition and operation shall be done by the Contractor and re-tested at no additional cost to the Owner.

3.2 CONTRACTOR'S ASSISTANCE

- A. Testing of Package equipment, as described in Section 16010, shall be as required in other Sections of this Specification.
- B. The Contractor shall provide the services of an electrician to assist either the Contractor or the equipment manufacturer's service representatives on any and all field test and adjustments as may be made or required by equipment manufacturers or the Contractor as the equipment is put into service. The Contractor shall make equipment manufacturers' service representatives available as required to assist in testing or putting equipment into operation.

END OF SECTION

CABLE TEST CERTIFICATE

1.0 TECHNICIAN INFORMATION

Company Name: _____ Contact Person: _____
 Address: _____ Phone No.: _____

2.0 CABLE IDENTIFICATION

Cable Designation or Circuit No.: _____
 Cable Source _____ Air Temperature _____
 Termination Point _____ Humidity _____
 Connected Equipment _____ Equipment Temperature _____
 Test Voltage _____ No. of Conductors _____ Age _____
 Length _____ Size _____ Operating Voltage _____
 Cable Type _____ Rated Voltage _____ Ground Type _____
 Manufacturer _____ Insulation Type _____
 Insulation Thickness _____ Installed In _____
 Conductor Material _____

Phase Color Identification

Phase A: _____ Phase B: _____ Phase C: _____

3.0 TEST INSTRUMENT

Manufacturer _____ Model No. _____

4.0 POWER CABLE TEST – MEGGER TEST

Time Minutes	Phase A Megohms		Phase B Megohms		Phase C Megohms	
	Before	After	Before	After	Before	After
.25						
.50						
.75						
1.00						
1.25						
1.50						
1.75						
2.00						
2.25						
2.50						
2.75						
3.0						
4.0						
5.0						

5.0 CERTIFICATION

I certify that the above information is correct and that the cable installation and condition conforms to manufacturer and Contract Specification requirements, unless otherwise noted.

Technician Signature: _____ Date: _____

6.0 ENGINEER REVIEW

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Test Witnessed: Yes No Reviewer Signature: _____ Date: _____

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SECTION 16970

CALIBRATION AND START-UP OF SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Requirements for Setup and Calibration of devices and instruments.
- B. Requirements for Start-up of Systems furnished/installed under this Contract.

1.2 RELATED SECTIONS

- A. Section 01400 - Quality Control: Manufacturer's Field Reports.
- B. Section 16010 - General Electrical, Instrument, and Control Requirements.
- C. Section 16050 - Basic Electrical Materials and Methods.
- D. Section 16960 - Electrical Testing and Equipment.

1.3 REFERENCES

- A. All setup, calibration, and workmanship shall be in conformance with the following documents:
 - 1. National Electrical Code, latest approved edition.
 - 2. Any and all Federal, State, and/or local codes, ordinances, or regulations.
- B. All equipment shall be designed, constructed, installed, tested and calibrated in conformity with all requirements, as a minimum, of applicable standards of IEEE, NEMA, ISA, ANSI, ICEA, UL, and OSHA.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Indicate electrical characteristics and specifications; including layout of switches, buttons, displays, dimensions, weights, and external power requirements; and, list cables, connections and all available accessories.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit calibration, setup and programming documentation under provisions of Section 01700.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01700.

- B. Operation Data: Include bound copies of operating and programming instructions. Include component parts replacement, adjustments, and preventative maintenance procedures and materials.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and use of product(s).

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years documented experience.

1.8 REGULATORY REQUIREMENTS

- A. Furnish Products listed and classified by Underwriters Laboratories, Inc. (UL), Factory Mutual (FM), and/or Canadian Standards Association (CSA), as specifically indicated, and as acceptable to authority having jurisdiction, as suitable for purpose specified and indicated.
- B. All instruments and devices shall be in conformance with all applicable standards and requirements of ISA, IEEE, ANSI, NEMA, and Underwriters' Laboratories.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Section 01600.
- B. Accept products on site in factory containers. Inspect for damage.
- C. Turn products over to Owner immediately.

PART 2 PRODUCTS

None.

PART 3 EXECUTION

3.1 START-UP REQUIREMENTS

- A. Setup, calibration and start-up of equipment and/or systems shall be performed as described below, and per the requirements of the Section under which the equipment/system was furnished.
- B. The Contractor shall also verify operation of the facility's main control and monitoring systems and coordination with all other equipment and sub-systems.
- C. Prior to scheduling Start-up of any equipment and/or system, the Contractor shall have complied with the requirements of Section 16960, Electrical Testing and Equipment, and shall have submitted reports indicating successful completion of testing for the equipment/system being started.

- D. Prior to energizing and operating any equipment or system, the Contractor shall arrange for the manufacturer's representative to inspect the installation for compliance to the manufacturer's recommendations. As a part of this inspection, the Contractor and/or the manufacturer's service personnel shall set all protective devices as required by the Short Circuit, Flash Hazard, and Protective Devices Coordination Analyses specified under Section 16050.
- E. The Contractor shall energize the equipment/system and perform all setting of equipment limit and safety switches. The calibration of all sensing relays, and all timer/sequencer, etc. settings, along with any programming required for proper operation shall be made at this time. The Contractor shall then start-up the equipment/system and verify the proper operation of all features and functions as required by the Specifications and Drawings.
- F. After completing the above items, the Contractor shall schedule a "Witnessed" Start-up. Twenty-four (24) hours (minimum) written notice shall be given the Owner's Representative prior to performing any Start-up. Start-up shall be scheduled at a time agreed upon by the Owner and the Contractor.
- G. Start-up and operation of the equipment and/or system shall be performed using the manufacturer's Operation and Maintenance Manual. Any deficiencies in the O & M Manual noted during Start-up shall be corrected prior to scheduling the Owner's Demonstration as specified under Section 16980. Start-up will be witnessed by the Owner's Representative.
- H. Verification of the start-up performance of the equipment and/or system shall be provided in the form of a start-up report, indicating that the Owner's Representative witnessed all functions and operations required of the equipment and/or system. Four (4) copies of all Start-up reports, as specified herein and in other Sections, shall be submitted to the Owner.
- I. All improperly functioning equipment not adapted to the purpose for which it is intended, or material, or equipment found to be faulty while performing the tests, shall be corrected; and any changes or repairs necessary to put the work in satisfactory condition and operation shall be done by the Contractor at no additional cost to the Owner. Start-up of the repaired equipment/system shall be witnessed by the Owner's Representative.
- J. Successful and approved completion of the Start-up requirements is a prerequisite to determining whether the Work or a portion of the Work is Substantially Complete as specified under Section 16010.

3.2 CONTRACTOR'S ASSISTANCE

- A. Setup, calibration, and Start-up of Package Equipment as described in Section 16010 shall be as required in other Sections of this Specification.
- B. The Contractor shall provide the services of an electrician to assist either the Contractor or the equipment manufacturer's service representatives on any and all field tests and adjustments as may be made or required by equipment manufacturers or the Contractor as the equipment is started up. The Contractor shall make equipment manufacturers' service representatives available as required to assist in putting equipment into operation.

END OF SECTION

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SECTION 16980

DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Requirements for Demonstration of equipment and/or systems for the Owner's personnel.
- B. Requirements for Training of Owner's personnel in the operation and maintenance of the equipment/system.
- C. Acceptance requirements.

1.2 RELATED SECTIONS

- A. Section 01400 - Quality Control: Manufacturer's Field Reports.
- B. Section 01700 - Contract Closeout.
- C. Section 16010 - General Electrical, Instrument, and Control Requirements.
- D. Section 16050 - Basic Electrical Materials and Methods.
- E. Section 16960 - Electrical Testing and Equipment.
- F. Section 16970 – Calibration and Start-up of Systems.

1.3 REFERENCES

- A. All equipment and workmanship shall be in conformance with the following documents:
 - 1. National Electrical Code (NEC), latest approved edition.
 - 2. Any and all Federal, State, and/or local codes, ordinances, or regulations.
- B. All equipment shall be designed, constructed, installed, and tested in conformity with all requirements, as a minimum, of applicable standards of IEEE, NEMA, ISA, ANSI, ICEA, UL and OSHA, except as modified herein.

PART 2 PRODUCTS

None.

PART 3 EXECUTION

3.1 DEMONSTRATION OF EQUIPMENT

- A. Demonstration of equipment and systems, and training of the Owner's personnel in the proper operation and maintenance of the equipment and systems shall be performed as required, as described below, and per the requirements of the Section under which the equipment/system was furnished.
- B. The following shall occur prior to scheduling demonstration and training of any equipment and/or system:
 - 1. The Contractor shall have fully complied with the requirements of Section 16970, Calibration and Start-up of Systems, and shall have submitted reports indicating successful completion of start-up for the equipment/system being started.
 - 2. Any deficiencies in the manufacturer's Operation and Maintenance (O&M) Manuals and/or "As-Built" drawings, noted during Start-up shall be corrected prior to scheduling the Owner's Demonstration and Training, as required per Section 16970.
 - 3. The Contractor shall submit for approval a proposed agenda for said demonstration/training, and shall adhere to the approved agenda for the demonstration and training session(s).
 - 4. Any and all test equipment, maintenance equipment, tools, or devices, and/or spare parts required to be furnished under Division 16 shall be turned over, and stored as required under Sections 01700 and 16010.
- C. After completing the above items, the Contractor shall schedule the Owner's Demonstration and Training. Seventy-two (72) hours (minimum) written notice shall be given the Owner's Representative prior to performing any Demonstration and/or Training. Such sessions shall be scheduled at a time agreed upon by the Owner and the Contractor. Multiple sessions shall be scheduled to allow attendance by all Owner's Personnel.
- D. The Demonstration shall instruct the Owner's personnel in all facets, features, and functions of the operation of the equipment and/or system. Training shall be performed using the manufacturer's Operation and Maintenance Manual and "As-Built" drawings, and shall familiarize the Owner's personnel in identifying improper operation, troubleshooting for the cause(s), and performing repair, replacement, and recalibration/setup necessary to correct the mis-operation. Use of any test equipment necessary, and a review of any recommended and/or provided spare parts shall be included in the Training.
- E. Verification of the Demonstration and Training for the equipment and/or system shall be provided in the form of a report, indicating that the Owner's personnel attended and witnessed all functions and operations required of the equipment and/or system, and received the required instruction. Demonstration and Training will be witnessed by the Owner's Representative and four (4) copies of all demonstration and training reports, as specified above and in other Sections, shall be submitted to the Owner.
- F. Successful and approved completion of the Demonstration and Training requirements is a prerequisite to determining whether the Work or a portion of the Work is Substantially Complete as specified under Section 16010.

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3.2 CONTRACTOR'S ASSISTANCE

- A. Demonstration and Training of Package Equipment, as described in Section 16010, shall be as required in other Sections of this Specification.
- B. The Contractor shall provide the services of an electrician to assist either the Contractor or the equipment manufacturers' service representatives on any and all field set-ups and adjustments as may be required to demonstrate operation of the equipment or system. The Contractor shall make equipment manufacturers' service representatives available as required to assist in demonstrating equipment operation.

3.3 CLEANUP

- A. Cleanup shall occur as required under Section 01700, and as specified under Section 16010.

3.4 ACCEPTANCE

- A. Acceptance shall occur after all the above requirements have been satisfied, and as per Section 01700.
- B. Acceptance of equipment and/or systems shall be signified by execution of Guarantees as described below.

3.5 GUARANTEES

- A. The equipment and installation furnished under Division 16 shall be guaranteed for a period of one (1) year as specified under Section 01700, Contract Closeout.
 - B. The Contractor's Guarantee shall be furnished as follows:
 - 1. Provide multiple copies.
 - 2. Execute for Owner's signature a certificate of Contractor's guarantee, listing date of acceptance as start of warranty period (except where indicated otherwise under the detailed equipment specifications), for all work and materials provided and installed under this Division.*
 - 3. Execute and assemble any and all transferable warranty and/or license documents from Subcontractors, suppliers, and manufacturers.
 - 4. Provide Table of Contents and assemble in three D, side ring binder with durable plastic cover.
- * For items of Work delayed beyond date of Substantial Completion, provide updated submittal within 10 days after acceptance, listing date of Owner's acceptance as start of warranty period.
- C. The Owner's dated signature on these documents shall constitute acceptance for warranty purposes.

END OF SECTION

SECTION 17000

CONTROL AND INFORMATION SYSTEM SCOPE AND GENERAL REQUIREMENTS

PART 1 -- GENERAL

1.1 SCOPE

- A. The Contractor shall provide, through the services of an instrumentation and control system subcontractor (ICSS), components, system installation services, as well as required and specified ancillary services in connection with the Instrumentation, Control and Information System.
- B. The System includes materials, labor, tools, fees, charges, and documentation required to furnish, install, test and place in operation a complete and operable instrumentation, control and information system.
- C. The system shall include measuring elements, signal converters, transmitters, local control panels, digital hardware and software, operator workstations, remote telemetry units, signal and data transmission systems, interconnecting wiring, and pertinent accessories.
- D. The scope of the work to be performed under this Division includes but is not limited to the following:
 - 1. The Contractor shall retain overall responsibility for the instrumentation and control system as specified herein.
 - 2. Furnish and install process instrumentation and associated taps and supports as scheduled or shown on the Drawings, unless otherwise noted or supplied by equipment vendors.
 - 3. Furnish and install local control panels, field panels and associated cabinets and panels as shown on the Drawings and as specified in Division 17.
 - 4. Furnish and install digital control system hardware and software as specified in Division 17.
 - 5. Final termination and testing of instrumentation and control system signal wiring and power supply wiring at equipment furnished under Division 17.
 - 6. Furnish, install and terminate special cables for devices (e.g., instruments). Furnish and terminate control system communication network cables.
 - 7. Furnish and install surge protection devices for digital equipment, local control panels, remote telemetry units, and instrumentation provided under this Division, including connections to grounding system(s) provided under Division 16.
 - 8. Coordinate grounding requirements with the electrical subcontractor for digital equipment, local control panels, and instrumentation provided under this Division. Terminate grounding system cables at equipment provided under this Division.
 - 9. Provide system testing, calibration, training and startup services as specified herein and as required to make systems fully operational.
- E. It is the intent of the Contract Documents to construct a complete and working installation. Items of equipment or materials that may reasonably be assumed as necessary to accomplish this end shall be supplied whether or not they are specifically stated herein.

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1.2 RELATED ITEMS

- A. Field mounted switches, torque switches, limit switches, gauges, valve and gate operator position transmitters, sump pump controls, and other instrumentation and controls furnished with mechanical or electrical equipment not listed in the instrument schedule shall be furnished, installed, tested, and calibrated as specified under other Divisions unless otherwise indicated.
- B. Additional and related work performed under Division 16 includes the following:
 - 1. Instrument A.C. power source and disconnect switch for process instrumentation, A.C. grounding systems, and A.C. power supplies for equipment, control panels and accessories furnished under Division 17.
 - 2. Conduit and raceways for instrumentation and control system signal wiring, grounding systems, special cables and communication network cables.
 - 3. Instrumentation and control system signal wiring.
 - 4. Install control system communication network cables.
 - 5. Furnish and install grounding systems for digital equipment, local control panels, remote telemetry units, and instrumentation provided under Division 17. Grounding systems shall be complete to the equipment provided under Division 17, ready for termination by the instrumentation subcontractor.
 - 6. Termination of instrumentation and control system signal wiring at equipment furnished under other divisions of the Specifications.
 - 7. Final wiring and termination to A.C. grounding systems and to A.C. power sources (e.g., panelboards, motor control centers, and other sources of electrical power).

1.3 GENERAL INFORMATION AND DESCRIPTION

- A. Where manufacturers are named for a particular item of equipment, it is intended as a guide to acceptable quality and performance and does not exempt such equipment from the requirements of these Specifications or Drawings.
- B. In order to centralize responsibility, it is required that equipment (including field instrumentation and control system hardware and software) offered under this Division shall be furnished and installed by the instrumentation subcontractor, or under the supervision of the instrumentation subcontractor, who shall assume complete responsibility for proper operation of the instrumentation and control system equipment, including that of coordinating signals, and furnishing appurtenant equipment.
- C. The Contractor shall retain total responsibility for the proper detailed design, fabrication, inspection, test, delivery, assembly, installation, activation, checkout, adjustment and operation of the entire instrumentation and control system as well as equipment and controls furnished under other Divisions of the Specifications. The Contractor shall be responsible for the delivery of detailed drawings, manuals and other documentation required for the complete coordination, installation, activation and operation of mechanical equipment, equipment control panels, local control panels, field instrumentation, control systems and related equipment/systems and shall provide for the services of a qualified installation engineer to supervise activities required to place the completed facility in stable operation under full digital control.

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- D. The instrumentation and control system shall be capable of simultaneously implementing all real time control and information system functions, and servicing all operator service requests as specified, without degrading the data handling and processing capability of other system components.
- E. Control system inputs and outputs are listed in Section 17920 – Control System - Input/Output Schedule. This information, together with the functional control descriptions, process and instrumentation diagrams, and electrical control schematics, describes the real time monitoring and control functions to be performed. In addition, the system shall provide various human machine interface and data reporting functions as specified in the software sections of this Specification.
- F. The mechanical, process, and electrical drawings indicate the approximate locations of field instruments, control panels, systems and equipment as well as field mounted equipment provided by others. The instrumentation subcontractor shall examine the mechanical, process and electrical drawings to determine actual size and locations of process connections and wiring requirements for instrumentation and controls furnished under this Contract. The ICSS shall inspect equipment, panels, instrumentation, controls, and appurtenances, either existing or furnished on the Project to determine requirements for interfacing with the control and information system. The Contractor shall coordinate the completion of required modifications with the associated supplier of the item furnished.
- G. The ICSS shall review and approve the size and routing of instrumentation and control cable and conduit systems furnished by the electrical subcontractor for suitability for use with the associated cable system.
- H. The Contractor shall coordinate the efforts of each supplier to aid in interfacing systems. This effort shall include, but shall not be limited to, the distribution of approved shop drawings to the electrical subcontractor and to the instrumentation subcontractor furnishing the equipment under this Division.
- I. The Contractor shall be responsible for providing a signal transmission system free from electrical interference that would be detrimental to the proper functioning of the instrumentation and control system equipment.
- J. The Owner shall have the right of access to the subcontractor's facility and the facilities of his equipment suppliers to observe materials and parts; witness inspections, tests and work in progress; and examine applicable design documents, records, and certifications during all stages of design, fabrication, and tests. The ICSS and his equipment suppliers shall furnish office space, supplies, and services required for these observation activities.
- K. The terms "Instrumentation," "Instrumentation and Control System," and "Instrumentation, Control and Information System" shall hereinafter be defined as equipment, labor, services, and documents necessary to meet the intent of the Specifications.

1.4 INSTRUMENTATION AND CONTROL SYSTEM SUBCONTRACTORS

- A. Instrumentation and control system subcontractors shall be regularly engaged in the detailed design, fabrication, installation, and startup of instrumentation and control systems for water and wastewater treatment facilities. Instrumentation and control system subcontractors shall

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have a minimum of five years of such experience and shall have completed a minimum of three projects of similar type and size as that specified herein. Where specific manufacturers/models of major hardware or software products (PLC, HMI software, network, etc.) are specified to be used on this project, the instrumentation and control system subcontractor shall have completed at least one project using that specified hardware or software. As used herein, the term "completed" shall mean that a project has been brought to final completion and final payment has been made.

- B. Acceptable instrumentation and control system subcontractors shall be:
1. Commerce Controls Inc.
Eric Hine
41069 Vincenti Court
Novi, MI 48375
 2. Perceptive Controls
Ryan Fisher
140 E Bridge St.
Plainwell, MI 49080

1.5 DEFINITIONS

- A. Solid State: Wherever the term solid state is used to describe circuitry or components in the Specifications, it is intended that the circuitry or components shall be of the type that convey electrons by means of solid materials such as crystals or that work on magnetic principles such as ferrite cores. Vacuum tubes, gas tubes, slide wires, mechanical relays, stepping motors or other devices will not be considered as satisfying the requirements for solid state components of circuitry.
- B. Bit or Data Bit: Whenever the terms bit or data bit are used in the Specification, it is intended that one bit shall be equivalent to one binary digit of information. In specifying data transmission rate, the bit rate or data bit rate shall be the number of binary digits transmitted per second and shall not necessarily be equal to either the maximum pulse rate or average pulse rate.
- C. Integrated Circuit: Integrated circuit shall mean the physical realization of a number of circuit elements inseparably associated on or within a continuous body to perform the function of a circuit.
- D. Mean Time Between Failures (MTBF): The MTBF shall be calculated by taking the number of system operating hours logged during an arbitrary period of not less than six months and dividing by the number of failures experienced during this period plus one.
- E. Mean Time to Repair (MTTR): The MTTR shall be calculated by taking the total system down time for repair over an arbitrary period of not less than six months coinciding with that used for calculation of MTBF and dividing by the number of failures causing down time during the period.
- F. Availability: The availability of a non-redundant device or system shall be related to its MTBF and MTTR by the following formula:

$$A = 100 \times (\text{MTBF}/(\text{MTBF} + \text{MTTR})) \text{ Percent}$$

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The availability of a device or system provided with an automatically switched backup device or system shall be determined by the following formula:

$$A = A2 + 1 - ((1 - A1) * (1 - A1))$$

where:

A1 = availability of non-redundant device or system

A2 = availability of device or system provided with an automatically switched backup device or system

G. Abbreviations: Specification abbreviations include the following:

1. A - Availability
2. ADC - Analog to Digital Converter
3. AI - Analog Input
4. AO - Analog Output
5. AVAIL - Available
6. BCD - Binary Coded Decimal
7. CSMA/CD - Carrier Sense Multiple Access/Collision Detect
8. CPU - Central Processing Unit
9. CRC - Cyclic Redundancy Check
10. CS - Control Strategy
11. DAC - Digital to Analog Converter
12. DBMS - Data Base Management System
13. DI - Discrete Input
14. DMA - Direct Memory Access
15. DO - Discrete Output
16. DPDT - Double Pole, Double Throw
17. DVE - Digital to Video Electronics
18. EPROM - Erasable, Programmable Read Only Memory
19. FDM - Frequency Division Multiplexing
20. FSK - Frequency Shift Keyed
21. HMI - Human Machine Interface (Software)
22. I/O - Input/Output
23. LAN - Local Area Network
24. LCD - Liquid Crystal Display
25. LDFW - Lead Follow
26. MCC - Motor Control Center
27. MTBF - Mean Time Between Failures
28. MTTR - Mean Time To Repair
29. OS - Operating System
30. PAC - Programmable Automation Controller
31. PCB - Printed Circuit Board
32. PID - Proportional Integral and Derivative Control
33. PLC - Programmable Logic Controller or Programmable Controller
34. PROM - Programmable Read Only Memory
35. RAM - Random Access Memory
36. RDY - Ready
37. RMSS - Root Mean Square Summation

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- 38. RNG - Running
- 39. ROM - Read Only Memory
- 40. RTU - Remote Telemetry Unit
- 41. SPDT - Single Pole, Double Throw
- 42. ST/SP - Start/Stop
- 43. TDM - Time Division Multiplexing
- 44. UPS - Uninterruptible Power Supply
- 45. VFD – Variable Frequency Drive

H. To minimize the number of characters in words used in textual descriptions on displays, printouts and nameplates, abbreviations may be used subject to the Engineer's approval. If a specified abbreviation does not exist for a particular word, an abbreviation may be generated using the principles of masking and or vowel deletion. Masking involves retaining the first and last letters in a word and deleting one or more characters (usually vowels) from the interior of the word.

1.6 ENVIRONMENTAL CONDITIONS

- A. Instrumentation equipment and enclosures shall be suitable for ambient conditions specified. All system elements shall operate properly in the presence of telephone lines, power lines, and electrical equipment.
- B. Inside control rooms and climate-controlled electrical rooms, the temperature will normally be 20 to 25 degrees C; relative humidity 40 to 80 percent without condensation and the air will be essentially free of corrosive contaminants and moisture. Appropriate air filtering shall be provided to meet environmental conditions (e.g., dust).
- C. Other indoor areas may not be air conditioned/heated; temperatures may range between 0 and 40 degrees C with relative humidity between 40 and 95 percent.
- D. Field equipment including instrumentation and panels may be subjected to wind, rain, lightning, and corrosives in the environment, with ambient temperatures from -20 to 40 degrees C and relative humidity from 10 to 100 percent. All supports, brackets, interconnecting hardware, and fasteners shall be aluminum, type 316 stainless steel, or metal alloy as otherwise suitable for chemical resistance within chemical feed/storage areas shown on the installation detail drawings.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

3.1 SCHEDULE OF PAYMENT

- A. Payment to the Contractor for Control and Information System materials, equipment, and labor shall be in accordance with the General and Supplementary Conditions. The schedule of values submitted as required by the General and Supplementary Conditions shall reflect a

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breakdown of the work required for completion of the Control and Information System. The breakdown shall include sufficient detail to permit the Engineer to administer payment for the Control and Information System.

3.2 CLEANING

- A. The Contractor shall thoroughly clean soiled surfaces of installed equipment and materials.
- B. Upon completion of the instrumentation and control work, the Contractor shall remove surplus materials, rubbish, and debris that has accumulated during the construction work. The entire area shall be left neat, clean, and acceptable to the Owner.

3.3 FINAL ACCEPTANCE

- A. Final acceptance of the Instrumentation, Control and Information System will be determined complete by the Engineer, and shall be based upon the following:
 - 1. Receipt of acceptable start up completion and availability reports and other documentation as required by the Contract Documents.
 - 2. Completion of the Availability Demonstration.
 - 3. Completion of control system training requirements.
 - 4. Completion of punch-list items that are significant in the opinion of the Engineer.
- B. Final acceptance of the System shall mark the beginning of the warranty period.

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SECTION 17030

CONTROL AND INFORMATION SYSTEM SUBMITTALS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall submit for review complete Shop Drawings for all equipment in accordance with the General Conditions and Division 1 of the Specifications. All submittal material shall be complete, legible, and reproducible, and shall apply specifically to this project.
- B. All submittal materials shall be tailored to this project by highlighting relevant items or crossing out non-applicable items. Generic submittals without identified options will be returned the Contractor without review.
- C. Compliance, Deviations, and Exceptions (CD&E) Letter:
 - 1. Where a named manufacturer and product is specified and a substitution or an “or equal” product is submitted, the submittal shall be accompanied by a “Compliance, Deviations, and Exceptions (CD&E) letter.” If the required submittal is submitted without the letter, the submittal will be rejected.
 - 2. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor, subcontractor (if applicable), and the equipment Manufacturer/Supplier. This letter shall include a copy of the Specification Section to which the submittal pertains. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in.
 - a. The letter "C" shall be for full compliance with the requirement.
 - b. The letter "D" shall be for a deviation from the requirement.
 - c. The letter "E" shall be for taking exception to a requirement.
 - 3. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions shall not be acceptable.
 - 4. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01300 – Submittals
- B. Section 17000 – Control and Information System Scope and General Requirements

1.3 EXISTING CONDITIONS / AS-BUILT DOCUMENTATION SUBMITTAL

- A. Prior to modifying, demolishing, removing, or decommissioning equipment, thoroughly investigate and document the existing conditions. Please note that Owner’s record drawings alone are not sufficient for documentation. The record drawings, if present, shall be verified in

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the field prior to submitting. Submit drawings, markup, sketches, information, or other materials for documenting the following existing conditions:

1. All I/O on PLC modules that have its wiring modified or new I/O terminated or for any PLC that is being decommissioned/removed/demolished. Document module number, point number, wire numbers, terminal numbers, destination, and function.
 2. All wiring entering or leaving a PLC that is being decommissioned, removed, or demolished that is not otherwise accounted for.
- B. When all information has been gathered, it shall be submitted to Engineer along with a clear and unequivocal statement that the existing conditions have been documented and understood. Contractor shall be held responsible for all issues that arise due to Contractor's modifications, demolition, removal, or decommissioning of existing equipment, including necessary reversion back to previous conditions.

1.4 DIGITAL HARDWARE SUBMITTALS

- A. Submit system block diagram(s) showing:
1. All equipment to be provided.
 2. All interconnecting cable.
 3. Equipment names, manufacturer, and model numbers.
 4. Equipment locations.
- B. Submit information for all digital equipment including, but not limited to, the following:
1. Bill of materials with equipment names, manufacturers, complete model numbers and locations.
 2. Catalog cuts, including complete part number breakdown information.
 3. Complete technical, material and environmental specifications.
 4. Assembly drawings.
 5. Mounting requirements.
 6. Color samples.
 7. Nameplates.
 8. Environmental requirements during storage and operation.

1.5 SOFTWARE SUBMITTALS

- A. Control Strategies
1. Description of automatic logic and all non-standard manual logic using plain English, for non-technical persons, and written in Contractor's own words. The write-up shall include references to associated I/O, tag/loop numbers, alarming/interlocks.
 2. Submitting language verbatim to Section 17950, Functional Control Descriptions, shall not be acceptable.
- B. Application Software
1. Provide application software documentation that contains program descriptions for the operation, modification, and maintenance of all application programs provided for the digital system.
 2. Application software includes all custom routines developed specifically for this project, or pre-written routines used for accomplishing specified functions for this project. This shall include any add-in custom software.

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- C. Graphic Displays
1. Submit all graphic displays required to perform the control and operator interface functions specified herein. Submitted graphic displays shall be for both new and modified graphics.
 2. Submit the complete set of graphic displays for review by the Owner and the Engineer at least 60 days prior to commencement of factory testing.
 3. Where a large number of graphic displays are required, submit an initial set of example displays for review before the complete set of displays is submitted. This initial set shall include examples of all basic graphic display design features and parameters and is intended to allow the Contractor to obtain preliminary approval of these features and parameters prior to beginning main graphic display production.
 4. The Contractor shall allow for one major cycle of revisions to the displays prior to factory testing and one minor cycle of revisions following factory test. A cycle of revisions shall be defined as all revisions necessary to complete a single set of changes marked by the Engineer and the Owner. Additional corrections shall be performed during start-up as required to accommodate changes required by actual field conditions, at no additional cost to the Owner.
 5. The required submittals in each revision cycle shall be full color prints of the entire set of displays.
 6. Displays shall be printouts of actual process graphics implemented in the system.

1.6 CONTROL PANEL SUBMITTALS

- A. Submittals shall be provided for all control panels, and shall include:
1. Exterior panel drawings with front and side views, to scale.
 2. Interior layout drawings showing the locations and sizes of all equipment and wiring mounted within the cabinet, to scale.
 3. Panel area reserved for cable access and conduit entry.
 4. Location plans showing each panel in its assigned location.
- B. Submit information for all exterior and interior panel mounted equipment including, but not limited to, the following:
1. Bill of materials with equipment names, manufacturers, complete model numbers and locations.
 2. Catalog cuts, including complete part number breakdown information.
 3. Complete technical, material and environmental specifications.
 4. Assembly drawings.
 5. Mounting requirements.
 6. Color samples.
 7. Nameplates.
 8. Environmental requirements during storage and operation.
- C. Submit panel wiring diagrams showing power, signal, and control wiring, including surge protection, relays, courtesy receptacles, lighting, wire size and color coding, etc.

1.7 INSTRUMENT SUBMITTALS

- A. Submit information on all field instruments, including but not limited to the following:
1. Product (item) name and tag number used herein and on the Contract Drawings.
 2. Catalog cuts, including complete part number breakdown information.

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3. Manufacturer's complete model number.
4. Location of the device.
5. Input output characteristics.
6. Range, size, and graduations.
7. Physical size with dimensions, NEMA enclosure classification, and mounting details.
8. Materials of construction of all enclosures, wetted parts and major components.
9. Instrument or control device sizing calculations where applicable.
10. Certified calibration data on all flow metering devices.
11. Environmental requirements during storage and operation.
12. Associated surge protection devices.
13. Installation drawings/details.

1.8 WIRING AND LOOP DIAGRAMS

- A. Submit interconnection wiring and loop diagrams for all panels and signals in the Control and Information System.
- B. Electrical interconnection diagrams shall show all terminations of equipment, including terminations to equipment and controls furnished under other Divisions, complete with equipment and cable designations. Where applicable, interconnection wiring diagrams shall be organized by input/output card. Interconnecting diagrams shall be prepared in a neat and legible manner on 11 X 17-inch reproducible prints.
- C. Loop drawings shall conform to the latest version of ISA Standards and Recommended Practices for Instrumentation and Control. Loop Drawings shall conform to ISA S5.4.
- D. Loop drawings shall not be required as a separate document provided that the interconnecting wiring diagrams required in Paragraph B., above, contain all information required by ISA 5.4.

1.9 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall deliver equipment operation and maintenance manuals in compliance with Section 01300, Submittals. Operation and maintenance (O&M) manuals shall consist of two basic parts:
 1. Manufacturer standard O&M manuals for all equipment and software furnished under this Division.
 2. Custom O&M information describing the specific configuration of equipment and software, and the operation and maintenance requirements for this particular project.
- B. The manuals shall contain all illustrations, detailed drawings, wiring diagrams, and instructions necessary for installing, operating, and maintaining the equipment. The illustrated parts shall be numbered for identification. All modifications to manufacturer standard equipment and/or components shall be clearly identified and shown on the drawings and schematics. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such illustrations shall be incorporated within the printing of the page to form a durable and permanent reference book.
- C. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operation and maintenance personnel unfamiliar with such equipment. The maintenance instructions shall

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include troubleshooting data and full preventive maintenance schedules. The instructions shall be bound in locking 3-D-ring binders with bindings no larger than 3.5 inches. The manuals shall include 15% spare space for the addition of future material. The instructions shall include drawings reduced or folded and shall provide the following as a minimum.

1. A comprehensive index.
 2. A functional description of the entire system, with references to drawings and instructions.
 3. A complete "as built" set of all approved shop drawings, which shall reflect all work required to achieve final system acceptance.
 4. A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.
 5. Full specifications on each item.
 6. Detailed service, maintenance, and operation instructions for each item supplied.
 7. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.
 8. Complete parts lists with stock numbers and name, address, and telephone number of the local supplier.
 9. References to manufacturers' standard literature where applicable.
 10. Warning notes shall be located throughout the manual where such notes are required to prevent accidents or inadvertent misuse of equipment.
- D. The operating instructions shall clearly describe the step by step procedures that must be followed to implement all phases of all operating modes. The instructions shall be in terms understandable and usable by operating personnel and maintenance crews and shall be useful in the training of such personnel.
- E. The maintenance instructions shall describe the detailed preventive and corrective procedures required, including environmental requirements during equipment storage and system operation, to keep the System in good operating condition. All hardware maintenance documentation shall make reference to appropriate diagnostics, where applicable, and all necessary wiring diagrams, component drawings and PCB schematic drawings shall be included.
- F. The hardware maintenance documentation shall include, as a minimum, the following information:
1. Operation Information: This information shall include a detailed description of how the equipment operates and a block diagram illustrating each major assembly in the equipment.
 2. Preventive Maintenance Instructions: These instructions shall include all applicable visual examinations, hardware testing and diagnostic routines, and the adjustments necessary for periodic preventive maintenance of the System.
 3. Corrective Maintenance Instructions: These instructions shall include guides for locating malfunctions down to the card replacement level. These guides shall include adequate details for quickly and efficiently locating the cause of an equipment malfunction and shall state the probable source(s) of trouble, the symptoms, probable cause, and instructions for remedying the malfunction.
 4. Parts Information: This information shall include the identification of each replaceable or field repairable component. All parts shall be identified on a list in a drawing; the identification shall be of a level of detail sufficient for procuring any

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repairable or replaceable part. Cross references between equipment numbers and manufacturer's part numbers shall be provided.

1.10 FINAL SYSTEM DOCUMENTATION

- A. All documentation shall be delivered to the Owner prior to final system acceptance in accordance with the Contract Documents. As a minimum, final documentation shall contain all information originally part of the control system submittals.
- B. Provide a complete set of detailed electrical interconnection diagrams required to define the complete instrumentation and control system. All diagrams shall be 11 X 17-inch original reproducible prints. All diagrams shall be corrected to describe final "as built" hardware configurations and to reflect the system configuration and control methodology adopted to achieve final system acceptance.
- C. Provide system software documentation for the operation and maintenance of all system software programs provided as a part of the digital system. All system software documentation shall be amended as required to delineate all modifications and to accurately reflect the final as built software configurations.
- D. Provide application software documentation that contains program descriptions for the operation, modification, and maintenance of all application programs provided for the digital system.
- E. Provide control strategy documentation which shall include control strategy (block oriented or ladder logic) diagrams to describe the control of all processes. Control strategy documentation shall reflect the system configuration and control methodology adopted to achieve final system acceptance. Control strategy documentation shall conform to the submittal requirements listed hereinabove.
- F. O&M documentation shall be amended with all final, adjusted values for all setpoints and other operating parameters for Owner reference.
- G. The Owner recognizes the fact that not all possible problems related to real time events, software interlocks, and hardware maintenance and utilization can be discovered during the Acceptance Tests. Therefore, the instrumentation subcontractor through the Contractor shall investigate, diagnose, repair, update, and distribute all pertaining documentation of the deficiencies that become evident during the warranty period. All such documentation shall be submitted in writing to the Owner within 30 days of identifying and solving the problem.

1.11 PROGRAMS AND SOURCE LISTINGS

- A. Provide one copy of all standard, of-the-shelf system and application software (exclusive of firmware resident software) on original media furnished by the software manufacturer.
- B. Provide one copy of source listings on digital media, acceptable to Engineer, for all custom software/logic written specifically for this facility, all database files configured for this facility, and all control strategies. All source listings shall include a program abstract, program linkage and input/output data. Comments describing the program flow shall be frequently interspersed throughout each listing.

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- C. All software/logic shall be in both its native format and in Adobe Portable Document Format.

1.12 SUBMITTAL/DOCUMENTATION FORMAT

- A. All drawing-type submittals and documentation shall be rendered and submitted in the latest version of AutoCAD.
- B. All textual-type submittals and documentation shall be rendered and submitted in the latest version of Microsoft Word or in searchable Adobe Portable Document Format (PDF). Raster scans will not be accepted.

1.13 ELECTRONIC O&M MANUALS

- A. Subject to acceptance by the Engineer, the O&M information may be submitted in part or in whole in an electronic format on digital media.
- B. Electronic O&M manuals shall contain information in standard formats (searchable Adobe PDF, Word, AutoCAD, HTML, etc.) and shall be easily accessible using standard, “off-the-shelf” software such as an Internet browser. Raster scans will not be accepted.

PART 2 PRODUCTS

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PART 3 EXECUTION

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SECTION 17040

CONTROL AND INFORMATION SYSTEM TRAINING REQUIREMENTS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. To familiarize the Owner's personnel with the process control system and field instrumentation, training shall be provided as detailed hereunder.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements

1.3 SUBMITTALS

- A. A minimum of 30 days prior to beginning training, submit a detailed training plan describing the following:
 - 1. A listing of all courses to be conducted.
 - 2. Course content.
 - 3. Applicability of each course to management, operations, maintenance, laboratory, etc., personnel.
 - 4. Course schedules.
 - 5. Qualifications and experience of individual(s) providing training.
- B. A minimum of 14 days prior to beginning each training course, submit documentation for use by the Owner's personnel during training. The training documentation shall be specific to the particular course, and shall include the following:
 - 1. A listing of all subjects to be covered.
 - 2. Course schedule.
 - 3. Documentation/lesson plans covering all subjects to be covered during the course instruction. Information shall be in a "how to" format, with sufficient background documentation and references to manufacturer literature to provide a thorough and clear understanding of the materials to be covered.

1.4 GENERAL REQUIREMENTS

- A. All costs of providing the training courses shall be borne by the Contractor.
- B. As used herein, the term "day" shall mean an eight-hour day, and the term "week" shall mean a five day, 40 hour week.
- C. Training courses, especially those for operator training, may be required to be scheduled during non-standard business hours (i.e., not between the hours of 8:00 am and 5:00 pm) to accommodate the working schedule of the Owner's personnel. No additional compensation will be awarded to the Contractor for training at non-standard hours.

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- D. All training courses shall complement the experience and skill levels of the Owner's personnel.
- E. Training courses shall be structured in order of increasing capability or security levels. The purpose of this requirement is to allow personnel with lesser training requirements or security password levels to drop out of the training at certain times while the training continues for personnel with greater requirements or higher security levels.
- F. All training courses shall include lecture as well as "hands on" experience for each of the attending personnel. The Contractor shall provide sufficient equipment for this to be accomplished. For example, training in which the instructor uses the computer and the Owner's personnel passively observe as the instructor demonstrates system functions shall not be acceptable.
- G. Unless otherwise specified, all training courses shall be conducted in the Owner's facilities.
- H. All training shall be completed prior to system acceptance.
- I. Standard manufacturer training courses are acceptable pending approval by the Engineer and Owner.

1.5 SYSTEM SUPERVISOR/ENGINEER TRAINING

- A. Provide manufacturer standard training in the use and configuration of the specified operator workstation (HMI or SCADA) software.
- B. System supervisor/engineer training shall be performed a minimum of 30 days prior to system startup.

1.6 OPERATOR TRAINING

- A. Two two-day courses comprised of daily half-day (four-hour) sessions for up to ten persons each shall be conducted to provide instruction in the use of the Control and Information System to monitor and control the facility.
- B. Operator training shall include familiarization training covering the Control and Information System. Operators shall be instructed in the names, locations, functions, and basic operation of all items of digital equipment and associated software.
- C. Operator training shall cover process and equipment operation both individually and collectively as an operating system. Normal as well as abnormal operating conditions shall be covered, including the response to failure occurrences and system alarms. All operator/system interactions shall be described.
- D. Operators shall be trained to instruct other operators and shall be provided with all course materials.

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1.7 MAINTENANCE TRAINING

- A. A half-day course shall be conducted for at least six persons prior to the start up of digital equipment at the Owner's plant. Instruction shall be provided in the following:
 - 1. Operating all digital equipment, including system start up and shutdown procedures.
 - 2. The use of hardware diagnostic routines, test equipment and test procedures as required to enable the Owner's personnel to detect and isolate system faults to the circuit board or module level and to implement repairs by replacing failed circuit boards or modules.
 - 3. Calibration and routine maintenance procedures for all analog and digital equipment.
- B. Step by step written procedures shall be provided for all preventive maintenance tasks and for identifying hardware faults to the circuit board or module level for all items of digital equipment.
- C. All digital equipment preventive and corrective maintenance training activities shall be limited to the use of commercially available off the shelf test equipment and to the use of diagnostic routines and hardware items which are the same as those to be provided as part of the system.

1.8 INSTRUMENT TRAINING

- A. A one-day course shall be provided at the Owner's facilities no more than three months prior to system start-up to instruct a minimum of five persons each in the calibration and preventive maintenance of the field instruments provided under this Contract.

1.9 GENERAL REFRESHER TRAINING

- A. A one-day general refresher training course shall be provided for up to ten persons 3-6 months after final system acceptance. Instruction shall be given in all aspects of the complete instrumentation and control system. Instructor(s) shall be capable of answering questions related to all aspects and details of the complete system.

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PART 3 -- EXECUTION
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SECTION 17050

TOOLS, SUPPLIES AND SPARE PARTS - GENERAL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide tools, supplies, and spare parts as specified herein for the operation and maintenance of the Control and Information System.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01300 – Submittals
- B. Section 17000 – Control and Information System Scope and General Requirements

PART 2 -- PRODUCTS

2.1 TOOLS

- A. Provide special tools, other than those normally found in an electronic technician's toolbox, required to test, diagnose, calibrate, install, wire, connect, disconnect, assemble and disassemble any digital equipment, instrument, panel, rack, cabinet or console mounted equipment for service and maintenance. This shall include, but not be limited to, the following: connector pin insertion and removal tools, wire crimping tools, special wrenches, special instrument calibrators, indicator lamp insertion and removal tools, etc.
- B. Provide tools and test equipment together with items such as instruction manuals, carrying/storage cases, unit battery charger where applicable, special tools, calibration fixtures, cord extenders, patch cords and test leads, which are not specified but are necessary for checking field operation of equipment supplied under this Division.
- C. One (1) Portable graphical multimeter with rechargeable battery, test leads, industrial lead set, and carrying case, Fluke Model 289, Simpson, or equal.
- D. Furnish one portable 4-20 mA, 24 VDC analog loop signal generator for calibration and testing of analog signal loops. Generator shall be furnished with rechargeable battery pack, test leads, spare battery pack, charger, carrying case and accessories. Signal generator shall be Fluke 787 ProcessMeter, or equal.
- E. Furnish one portable calibrator capable of measuring DC volts, mV, mA, ohms, frequency, T/C, peak detect and trip detect on its input and simultaneously generate on its output all of the preceding signals plus two wire simulation, ramp functions, up/down stepping and 10 point programmability. The calibrator shall be furnished complete with 24 VDC integral battery pack, spare battery pack, test leads, external charger, fuse pack, carrying case and

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appurtenances. It shall be possible to store and use automatic instrument calibration procedures that are downloaded from Windows-based instrument management software. Calibrator shall be Fluke 789 ProcessMeter, Ametek CL-9000, or equal.

- F. A complete computer technician kit in an injection molded or high-density polyethylene case. The kit shall be Model JTK 49 Workstation Kit by Stanley Supply Services of Phoenix, AZ, or a computer technician kit of equivalent equipment and value.

2.2 SUPPLIES

- A. The Contractor shall provide supplies as specifically required in other Sections of Division 17

2.3 SPARE PARTS

- A. Provide spare parts for items of control and instrumentation equipment as recommended by the manufacturer and in accordance with the Contract Documents.
- B. Furnish all spares in moisture proof boxes designed to provide ample protection for their contents. Label all boxes to clearly identify contents and purpose.
- C. The Contractor shall replace all spare parts consumed during installation, testing, start up, the system availability demonstration, and the guarantee period.
- D. Refer to individual digital hardware and instrument sections for additional requirements specific to those devices.

PART 3 -- EXECUTION

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SECTION 17060

SIGNAL COORDINATION REQUIREMENTS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall conform to the signal coordination requirements specified herein.
- B. The Contractor shall be responsible for coordinating signal types and transmission requirements between the various parties providing equipment under this Contract. This shall include, but not be limited to, distribution of appropriate shop drawings among the equipment suppliers, the electrical subcontractor, the HVAC subcontractor, and the ICSS.
- C. Analog signals shall be signals for transmitting process variables, etc. from instruments and to and from panels, equipment PLCs and Control System PLCs.
- D. Discrete signals shall consist of contact closures or powered signals for transmitting status/alarm information and control commands between starters, panels, equipment PLCs, the Control System, etc.

1.2 ANALOG SIGNAL TRANSMISSION

- A. Signal transmission between electric or electronic instruments, controllers, and all equipment and control devices shall be individually isolated, linear 4 20 milliamperes and shall operate at 24 VDC.
- B. Signal output from all transmitters and controllers shall be current regulated and shall not be affected by changes in load resistance within the unit's rating.
- C. All cable shields shall be grounded at one end only, at the control panel, with terminals bonded to the panel ground bus.
- D. Analog signal isolation and/or conversion shall be provided where necessary to interface with instrumentation, equipment controls, panels, and appurtenances.
- E. Non-standard transmission systems such as pulse duration, pulse rate, and voltage regulated shall not be permitted except where specifically noted in the Contract Documents. Where transmitters with nonstandard outputs do occur, their outputs shall be converted to an isolated, linear, 4 20 milliampere signal.
- F. The Contractor shall provide 24 V power supplies for analog signals and instruments where applicable and as required inside panels, controls, etc.
- G. Where two-wire instruments transmit directly to the Control and Information System, the instrumentation subcontractor shall provide power supplies at the PLC-equipped control panels for those instruments.

- H. Where four-wire instruments with on-board loop power supplies transmit directly to the Control and Information System, the instrumentation subcontractor shall provide necessary signal isolators or shall otherwise isolate the input from the Control and Information System loop power supply. Similar provisions shall be made when a third element such as a recorder, indicator, or single loop controller with integral loop power supply is included in the loop.

1.3 DISCRETE INPUTS

- A. All discrete inputs to equipment and Control and Information System PLCs, from field devices, starters, panels, etc., shall be unpowered (dry) contacts in the field device or equipment, powered from the PLCs, unless specified otherwise.
- B. Sensing power (wetting voltage) supplied by the PLC shall be 24 VDC [120 VAC].

1.4 DISCRETE OUTPUTS

- A. All discrete outputs from local control panels and Control and Information System PLCs to field devices, starters, panels, etc., shall be 24 VDC [120 VAC] powered (sourced) from PLC's [dry contact relay outputs].
- B. PLC powered discrete outputs shall energize 24 VDC pilot relay coils in the field devices, starters, panels, etc. which in turn open or close contacts in the associated control circuit. The 24 VDC relay coil, contacts, and associated control circuitry shall be furnished integral with the field device, starter, panel, etc. by the supplier and contractor furnishing the field device, starter, or panel.
- C. Where required or specified herein, discrete outputs from equipment and Control and Information System PLC's to field devices, starters, panels, motor operated valves, etc., shall be dry contact or relay outputs.
- D. Outputs to solenoid valves shall be 120 VAC, powered from the PLC or control panel unless specified or shown otherwise.

1.5 OTHER DISCRETE SIGNALS

- A. Discrete signals between starters, panels, etc. where no 24 VDC power supply is available may be 120 VAC, as long as such contacts are clearly identified in the starter, panel, etc. as being powered from a different power supply than other starter/panel components.
- B. Where applicable, warning signs shall be affixed inside the starter, panel, etc. stating that the panel is energized from multiple sources.
- C. Output contacts in the starter, panel, etc., that are powered from other locations shall be provided with special tags and/or color-coding. Disconnecting terminal strips shall be provided for such contacts.
- D. The above requirements shall apply to all starters and panels, regardless of supplier.

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PART 2 -- PRODUCTS
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PART 3 -- EXECUTION
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SECTION 17070

CONTROL AND INFORMATION SYSTEM TESTING - GENERAL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall test the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17072 – Field Testing
- C. Section 17073 – Final Acceptance Test

1.3 SUBMITTALS

- A. For each of the specified tests, submit a test plan to the Engineer at least one month in advance of commencement of the tests. The test plan shall contain the following at a minimum:
 - 1. A schedule of all testing to be conducted.
 - 2. A brief description of the testing to be performed
 - 3. Test objectives.
 - 4. Testing criteria per the Specifications.
 - 5. Check lists and procedures for performing each of the specified tests.
 - 6. Sample test result documentation.
 - 7. Requirements for other parties.

1.4 GENERAL REQUIREMENTS

- A. All system start up and test activities shall follow detailed test procedures; check lists, etc., previously approved by the Engineer. The Engineer shall be notified at least 21 days in advance of any system tests and reserves the right to have his and/or the Owner's representatives in attendance.
- B. The Contractor shall provide the services of experienced factory trained technicians, tools and equipment to field calibrate, test, inspect, and adjust all equipment in accordance with manufacturer's specifications and instructions.
- C. The Contractor (or designee) shall maintain master logbooks for each phase of installation, startup and testing activities specified herein. Each logbook shall include signal, loop or control strategy tag number, equipment identification, description and space for sign off dates, Contractor signature and Engineer signature. Example test documentation specific to each phase of testing shall be approved prior to initiation of that testing, as specified hereinabove.

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- D. All test data shall be recorded on test forms, previously approved by the Engineer. When each test has been successfully completed, a certified copy of all test results shall be furnished to the Engineer together with a clear and unequivocal statement that all specified test requirements have been met and that the system is operating in accordance with the Contract Documents.

- E. The Engineer will review test documentation in accordance with the Contract Documents and will give written notice of the acceptability of the tests within 10 days of receipt of the test results.

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PART 3 -- EXECUTION
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SECTION 17072

FIELD TESTING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall perform field testing on the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17070 – Control and Information System Testing, General
- C. Section 17073 – Final Acceptance Test

1.3 GENERAL REQUIREMENTS

- A. Control system start up and testing shall be performed to ensure that all plant processes shall be systematically and safely placed under digital control in the following order:
 - 1. Primary elements such as transmitters and switch devices shall be calibrated and tested as specified in Sections 17600 – Instruments, General
 - 2. Each final control element shall be individually tested as specified hereinafter.
 - 3. Each control loop shall be tested as specified hereinafter.
 - 4. Each control strategy shall be tested under automatic digital control as specified hereinafter.
 - 5. The entire control system shall be tested for overall monitoring, control, communication, and information management functions, and demonstrated for system availability as specified hereinafter.
- B. System start up and test activities shall include the use of water, if necessary, to establish service conditions that simulate, to the greatest extent possible, normal operating conditions in terms of applied process loads, operating ranges and environmental conditions.
- C. Each phase of testing shall be fully and successfully completed and all associated documentation submitted and approved prior to the next phase being started. Specific exceptions are allowed if written approval has been obtained in advance from the Engineer.

1.4 CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall ensure that all mechanical equipment, equipment control panels, local control panels, field instrumentation, control system equipment and related equipment and/or systems are tested for proper installation, adjusted and calibrated on a loop by loop basis prior to control system startup to verify that each is ready to function as specified. Each test shall

be witnessed, dated and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

- B. The Contractor shall be responsible for coordination of meetings with all affected trades. A meeting shall be held each morning to review the day's test schedule with all affected trades. Similarly, a meeting shall be held each evening to review the day's test results and to review or revise the next day's test schedule as appropriate.
- C. The Contractor shall ensure that the electrical subcontractor conforms to the start up, test and sign off procedures specified herein to assure proper function and coordination of all motor control center control and interlock circuitry and the transmission of all discrete and/or analog signals between equipment furnished by the electrical subcontractor and the control system specified herein.
- D. The Contractor shall ensure that the HVAC subcontractor conforms to the start up, test and sign off procedures specified herein to assure proper function of all HVAC system control and interlock circuitry and the transmission of all discrete and/or analog signals between HVAC equipment and controls and the control system specified herein.

1.5 FINAL CONTROL ELEMENT TESTING

- A. The proper control of all final control elements shall be verified by tests conducted in accordance with the requirements specified herein.
- B. All modulating final control elements shall be tested for appropriate speed or position response by applying power and input demand signals, and observing the equipment for proper direction and level of reaction. Each final control element shall be tested at 0, 25, 50, 75, and 100 percent of signal input level and the results checked against specified accuracy tolerances. Final control elements, such as VFD's, that require turndown limits shall be initially set during this test.
- C. All non-modulating final control elements shall be tested for appropriate position response by applying and simulating control signals, and observing the equipment for proper reaction.

1.6 LOOP CHECKOUT

- A. Prior to control system startup and testing, each monitoring and control loop shall be tested on an individual basis from the primary element to the final element, including the operator workstation or loop controller level, for continuity and for proper operation and calibration.
- B. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses. Simulated input data signals may be used subject to prior written approval by the Engineer. All modes of control shall be exercised and checked for proper operation.
- C. The accuracy of all DAC's shall be verified by manually entering engineering unit data values at the operator workstation and then reading and recording the resulting analog output data.
- D. The accuracy of all ADC's shall be verified using field inputs or by manually applying input signals at the final controller, and then reading and recording the resulting analog input data at the operator workstation.

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- E. Each loop tested shall be witnessed, dated and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

1.7 CONTROL SYSTEM STARTUP AND TESTING

- A. Control system startup and testing shall be performed to demonstrate complete compliance with all specified functional and operational requirements. Testing activities shall include the simulation of both normal and abnormal operating conditions.
- B. All digital hardware shall be fully inspected and tested for function, operation and continuity of circuits. All diagnostic programs shall be run to verify the proper operation of all digital equipment.
- C. Final control elements and ancillary equipment shall be tested under start up and steady state operating conditions to verify that proper and stable control is achieved using local area control panels, motor control center circuits, and local field mounted control circuits. All hardwired control circuit interlocks and alarms shall be operational. The control to final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits.
- D. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses for final control elements. Simulated input data signals may be used subject to prior written approval by the Engineer.
- E. Each control strategy shall be tested to verify the proper operation of all required functions. The control system start up and test activities shall include procedures for tuning all control loops incorporating PID control modules, and for adjusting and testing all control loops as required to verify specified performance.
- F. The control system start up and test activities shall include running tests to prove that the Instrumentation, Control and Information System is capable of continuously, safely and reliably regulating processes, as required by the Contract, under service conditions that simulate, to the greatest extent possible, normal plant operating ranges and environmental conditions.
- G. A witnessed functional acceptance test shall be performed to demonstrate satisfactory performance of individual monitoring and control loops and control strategies. At least one test shall be performed to verify that the control and instrumentation system is capable of simultaneously implementing all specified operations.
- H. Each loop and control strategy test shall be witnessed and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.
- I. Control system startup and testing shall be performed to demonstrate complete compliance with all specified functional and operational requirements. Testing activities shall include the simulation of both normal and abnormal operating conditions.

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1.8 FACILITY STARTUP COORDINATION

- A. Facility start up shall comply with requirements specified in the Contract Documents and those requirements specified herein. Facility start up shall commence after all previously described start up and test activities have been successfully completed and shall demonstrate that the Instrumentation, Control and Information System can meet all Contract requirements with equipment operating over full operating ranges under actual operating conditions.
- B. The control system start up period shall be coordinated with process startup activities and shall be extended as required until all plant processes are fully operational and to satisfy the Engineer that all control system Contract requirements have been fulfilled in accordance with the Contract Documents.
- C. The instrumentation subcontractor's personnel shall be resident at the facility to provide both full time (eight hours/day, five days/week) and 24 hours on call (seven days/week) support of operating and maintenance activities for the duration of the start up period.
- D. At least one qualified control systems technician shall be provided for control system startup and test activities and at least two when loop checkout is being performed.

PART 2 -- PRODUCTS
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PART 3 -- EXECUTION
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END OF SECTION

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SECTION 17073
FINAL ACCEPTANCE TEST

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall perform the Final Acceptance Test on the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17070 – Control and Information System Testing, General
- C. Section 17072 – Field Testing

1.3 AVAILABILITY DEMONSTRATION AND FINAL SYSTEM ACCEPTANCE

- A. Upon completion of all control system startup activities and prior to final system acceptance, the Contractor shall demonstrate that the availability of the entire control system, including operation under conditions of digital equipment fail over, initiated either automatically or manually, shall be not less than 99.8 percent during a 30-day availability test period. The Owner shall be given two (2) weeks notice of the starting date of the 30-day availability test.
- B. If the system fails the 30-day availability test, the 30-day test period shall be restarted after the failed component or software is repaired/replaced and full operation is restored. The system shall be demonstrated for the full 30-day period following the restart.
- C. The Contractor shall submit an availability demonstration report that shall state that all system availability requirements have been met.

PART 2 -- PRODUCTS
(NOT USED)

PART 3 PART 3 -- EXECUTION
(NOT USED)

END OF SECTION

SECTION 17080

QUALITY ASSURANCE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. It is the intent of these Specifications and Drawings to secure high quality in materials, equipment and workmanship in order to facilitate operations and maintenance of the facility. The Contractor shall provide equipment and services to meet this intent.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. All Work shall be installed in accordance with the National Electric Code, National Electric Safety Code, OSHA, State/Commonwealth, local and other applicable codes.

1.3 QUALITY ASSURANCE - GENERAL

- A. All equipment and materials shall be new and the products of reputable recognized suppliers having adequate experience in the manufacture of these particular items.
- B. For uniformity, only one manufacturer and model will be accepted for each type of product. Where differing models are required, equipment from a single manufacturer shall be provided.
- C. Equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for stresses that may occur during fabrication, transportation, and erection as well as during continuous or intermittent operation. They shall be adequately stayed, braced and anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details.
- D. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, which shall be of sturdy and durable construction and be suitable for long, trouble free service.
- E. Electronic components shall be de-rated to assure dependability and long term stability.
- F. Printed circuit boards in field mounted equipment shall be suitable for the specified environmental conditions.
- G. Alignment and adjustments shall be non-critical, stable with temperature changes or aging and accomplished with premium grade potentiometers.
- H. Components of specially selected values shall not be inserted into standard electronic assemblies in order to meet the performance requirements of this specification.

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1.4 OPTIONAL EQUIPMENT

- A. Optional or substituted equipment or both requiring changes in details or dimensions required to maintain structural, mechanical, electrical, control, operating, maintenance or design features incorporated in these Specifications and Drawings shall be made at no additional cost to the Owner. In the event that the changes are necessary, calculations and drawings showing the proposed revisions shall be submitted for approval. The Contractor shall coordinate changes with other affected trades and contracts and pay additional charges incurred.

1.5 GUARANTEE

- A. The instrumentation subcontractor through the Contractor shall install, maintain and guarantee the Instrumentation, Control and Information System as specified under the General Conditions and Division 1 of the Specifications. Maintenance personnel provided by the instrumentation subcontractor shall instruct the Owner's personnel in the operation, adjustment, calibration and repair of the equipment being serviced. Preventive and corrective activities shall be documented with service reports, which shall identify the equipment being serviced, state the condition of the equipment, describe Work performed and list materials used. A copy of service reports shall be delivered to the Owner on the day the Work is performed.
- B. The instrumentation subcontractor shall provide the services of factory trained service technician(s) at least twice during the guarantee period, for the purpose of performing preventive hardware maintenance.
- C. Corrective hardware and software maintenance during the guarantee period shall be performed in accordance with the requirements of Division 01 and, in addition, shall meet the following requirements:
 - 1. Corrective hardware maintenance shall be performed by factory trained service technician(s) specifically trained to service the digital equipment provided. Technicians possessing suitable training and experience shall be provided to perform corrective maintenance on other equipment. The hardware service technician(s) shall be available on site within 24 working hours after notification by the Owner.
 - 2. Corrective software maintenance shall be performed for software provided by the instrumentation subcontractor and incorporated into the system prior to the completion of system commissioning. Software service programmer(s) shall be available for consultation within four business hours and, if required, on site within 16 business hours after notification by the Owner. Corrective software maintenance shall include the supply, installation and startup of application software upgrades released during the guarantee period.
 - 3. Corrective hardware and software maintenance performed during the guarantee period shall be performed at no cost to the Owner.
 - 4. As used herein, the term "working hours" shall be defined as those of the treatment facility (seven days per week, 24 hours per day). The term "business hours" shall be defined as the hours between 8:00 a.m. and 5:00 p.m., local time, Monday through Friday; excluding holidays.
 - 5. The guarantee period shall commence upon final acceptance of the completed treatment facility in accordance with the provisions of the Contract Documents.

- D. The instrumentation subcontractor shall submit to the Owner a proposed maintenance agreement incorporating the following features:
 - 1. Extension of preventive hardware maintenance services as described above for a period of up to five years from the expiration of the warranty period.
 - 2. Provisions for corrective hardware or software maintenance Work on a will call basis for a period of up to five years from the expiration of the warranty period. Corrective maintenance Work shall be performed by properly trained personnel as described above.
- E. The proposed agreement shall include provisions for payment based upon an annual fee for preventive maintenance and cost plus expenses for corrective maintenance Work. The portion dealing with corrective maintenance shall be written to include corrective maintenance caused by actions of the Owner during the warranty period and shall contain clauses for re-negotiation of contract prices based upon changes in recognized economic indicators published by the United States Department of Commerce.

1.6 SHIPPING HANDLING AND STORAGE

- A. In addition to shipping, handling and storage requirements specified elsewhere in the Contract Documents, air conditioning/heating shall be provided for storage of field instrumentation, panels, digital equipment and ancillary devices to maintain temperatures between 20 and 25 degrees C and relative humidity 40 to 60 percent without condensation. The air shall be filtered and free of corrosive contaminants and moisture.

1.7 FABRICATION

- A. Fabrication of equipment shall conform to the codes and standards outlined in this Section, and other portions of the Contract Documents.

PART 2 -- PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Instrumentation and control system installation Work, whether new construction or modifications to existing equipment/panels/structures, shall conform to the codes and standards outlined in this Section, and other portions of the Contract Documents.
- B. The instrumentation subcontractor shall assign a competent representative who shall provide full time coordination and supervision of on site instrumentation and control system construction Work from commencement of construction through completion and final acceptance.
- C. Labor shall be performed by qualified craftsmen in accordance with the standards of workmanship in their profession and shall have had a minimum of three years of documented experience on similar projects.

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- D. Equipment and materials shall fit properly in their installations. Work required to correct improperly fit installations shall be performed at no additional expense to the Owner.
- E. Work shall be performed in a neat and workmanlike manner. Hardware and instrumentation shall be installed in accordance with requirements specified herein, in accordance with industry best practices, in accordance with manufacturers' recommendations, and in a manner suitable for ease of operation, inspection, and maintenance. Wiring shall be neatly bundled, run in wireway, and terminated. Spare wiring shall be neatly coiled and clearly labeled at both ends for future use by the Owner. Work not meeting these requirements shall be corrected at no expense to the Owner.
- F. Sufficient common mode and differential mode noise rejection shall be provided to ensure proper operation of the plant process control system. General practices shall include:
 - 1. Maintaining crossings between noisy wires and signal wires at right angles.
 - 2. Maintaining separation between noisy wires and signal wires as wide as practical.
 - 3. Grounding all signals, shields and power supplies at the process control unit or local control panel.
 - 4. Providing passive filters on signals with time constant compatible with scan intervals and overvoltage protection.
 - 5. Eliminating cable splices. Splices in instrumentation and control system signal, network, and instrument manufacturer furnished cables shall be approved in advance by the Engineer.
 - 6. Providing a floating output for transmitters that have their own power sources.
- G. DC and AC power grounding shall be performed in accordance with the digital hardware manufacturer's recommendations as well as all applicable code requirements.
- H. The case of each field instrument and control panel shall be grounded in compliance with the National Electric Code.
- I. Power wires shall be separated from parallel running signal wires by the following minimum spacing:
 - 1. 120 VAC: 12 in
 - 2. 240 VAC: 18 in
 - 3. 480 VAC: 18 in
 - 4. 2000 VAC and above: 24 in
- J. The Contractor shall provide all required cutting, drilling, inserts, supports, bolts, and anchors, and shall securely attach all equipment and materials to their supports. Embedded supports for equipment furnished under this Division shall be provided and installed as shown specified herein and shown on the Drawings.
- K. Following acceptance of the factory tests by the Engineer, and in accordance with the construction schedule, the Contractor shall commence installation of the digital control system hardware. Digital system equipment items shall not be installed, however, until all architectural, mechanical, HVAC and electrical Work has been completed in the equipment rooms, MCCs, control rooms and all structural and mechanical Work has been completed within 50 feet of equipment locations.

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- L. Upon completion of the above construction Work, the Contractor shall request an inspection of the above named areas. The Engineer will issue a written approval to proceed with delivery and installation only after being satisfied that all Work described above has been properly performed. Digital equipment shall remain at the factory site or storage prior to approval for delivery to the project site. Partial shipments may be required to meet construction schedule requirements.

END OF SECTION

SECTION 17125

OPERATOR INTERFACE TERMINALS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation all operator interface units, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements

PART 2 -- PRODUCTS

2.1 OPERATOR INTERFACE TERMINAL – LARGE

- A. An Operator Interface Terminal (OIT) shall be provided to view and change PLC monitoring and control parameters and to display alarm messages using a graphical user interface. The OIT shall provide the following features as a minimum:
 - 1. Minimum of 10.4-inch diagonal display
 - 2. 18-bit color TFT LCD 800 x 600 SVGA display
 - 3. Backlit analog resistive touch screen interface w/ 1 million press actuation rating
 - 4. Backlight w/ min. 50,000-hour life to half brightness
 - 5. Minimum of 512 MB internal storage
 - 6. Minimum of 512 MB RAM application memory
 - 7. Minimum of 80 MB nonvolatile user memory
 - 8. Windows CE Operating System
 - 9. Battery-backed real-time clock
 - 10. Secure Digital (SD) card slot w/ min. 2 GB card
 - 11. One USB 2.0 high-speed Type A host port; one USB 1.0 high-speed Type B device port
 - 12. One 10/100Base-T Auto MDI/MDI-X Ethernet port
 - 13. Windows-based configuration software complete with download cable
 - 14. Operating Voltage: 120 VAC or 24 VDC (internal or via independent power supply)
 - 15. Enclosure Rating: NEMA 12/4X to match the associated PLC cabinet rating
 - 16. Environment: 0-55°C, 5-95% relative humidity, non-condensing
- B. The operator interface unit shall be Allen-Bradley PanelView Plus 7 Standard 1000, or equal.

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2.2 OPERATOR INTERFACE TERMINAL – SMALL

- A. An Operator Interface Terminal (OIT) shall be provided to view and change PLC monitoring and control parameters and to display alarm messages using a graphical user interface. The OIT shall provide the following features as a minimum.
 - 1. Minimum of 6.5-inch diagonal display
 - 2. 18-bit color TFT LCD 640 x 480 VGA display
 - 3. Backlit analog resistive touch screen interface w/ 1 million press actuation rating
 - 4. Backlight w/ min. 50,000 hr life to half brightness
 - 5. Minimum of 512 MB internal storage
 - 6. Minimum of 512 MB RAM application memory
 - 7. Minimum of 80 MB nonvolatile user memory
 - 8. Windows CE Operating System
 - 9. Battery-backed real-time clock
 - 10. Secure Digital (SD) card slot w/ min. 2 GB card
 - 11. One USB 2.0 high-speed Type A host port; one USB 1.0 high-speed Type B device port
 - 12. One 10/100Base-T Auto MDI/MDI-X Ethernet port
 - 13. Windows-based configuration software complete with download cable
 - 14. Operating Voltage: 120 VAC or 24 VDC (internal or via independent power supply)
 - 15. Enclosure Rating: NEMA 12/4X to match the associated PLC cabinet rating
 - 16. Environment: 0-55°C, 5-95% relative humidity, non-condensing
- B. The operator interface unit shall be Allen-Bradley PanelView Plus 7 Standard 700, or equal.

PART 3 -- EXECUTION

3.1 REQUIREMENTS

- A. The OIT shall be configured to display all PLC I/O, setpoints, and parameters. All equipment failures shall be alarmed. PLC I/O values and operator-entered setpoints shall be displayed with associated units and service descriptions. Menus shall be provided to navigate between screens of different equipment items. Displays shall be arranged in a hierarchical structure with displays for specific equipment items grouped together. Additional functionality shall be as specified elsewhere in this Division.
- B. All necessary configuration and programming software shall be provided on optical media and turned over to the Owner.
- C. Unless otherwise indicated, each OIT shall be mounted between 48 and 60 inches above the floor or work platform.
- D. Refer to Section 17000 - Control and Information System Scope and General Requirements for additional requirements.

END OF SECTION

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SECTION 17180

PROCESS CONTROL SYSTEM NETWORKS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation IEEE 802.3 Ethernet local area network(s) for communications among plant devices.
- B. Local area network shall be provided with all spare parts, accessories, and appurtenances as herein specified.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements

1.3 TOOLS, SUPPLIES AND SPARE PARTS

- A. The following specific spare parts items shall be provided:
 - 1. A termination tool kit shall be provided containing all required tools and consumables for up to 25 connections of each connection type furnished. Termination kit shall be as manufactured by Black Box, Corning Cable Systems, Optical Cable Corporation, or equal.
 - 2. One spare switch of each type furnished under this Contract.

PART 2 -- PRODUCTS

2.1 LOCAL AREA NETWORK (LAN)

- A. An IEEE 802.3 Ethernet local area network shall be used for communications between plant devices.
- B. Network wiring shall be unshielded, twisted-pair copper cables for connections within buildings. Fiber optic media shall be used for all inter-device communication links extended outside of a building, unless specifically noted. Cables shall be as specified herein.
- C. The Contractor may provide a network configuration different from that shown in the Contract Drawings with written approval of the Engineer, but the Contractor shall coordinate with all affected trades and pay for all additional charges incurred.
- D. The Contractor shall supply all hardware, cables, connectors, and software to implement a network as specified herein and shown on drawings.

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2.2 UNSHIELDED TWISTED PAIR CABLE

- A. Unshielded twisted pair cable for drops within buildings shall consist of 4 pair of 24 AWG copper conductors in a flame-retardant jacket. Cable shall be plenum rated (UL 910) and meet EIA/TIA-568 Category 6 specifications. Unshielded twisted pair cable shall be Hyper Grade Extended Distance cable as manufactured by Berk-Tek, Belden equivalent, or equal. Connectors shall be modular RJ-45 plug.

PART 3 -- EXECUTION

3.1 REQUIREMENTS

- A. The destination of all network data cables (both copper and fiber) leaving an enclosure, patch panel, or building shall be labeled at each end using industry-standard wire markers.
- B. Refer to Section 17000 - Control and Information System Scope and General Requirements, Part 3 of the Specifications for additional requirements.

END OF SECTION

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SECTION 17200

CONTROL AND INFORMATION SYSTEM SOFTWARE REQUIREMENTS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, test, install, and place in satisfactory operation all control and information system software with all required programming and software appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17920 – Control System Input/Output Schedule
- C. Section 17950 – Functional Control Descriptions

PART 2 - PRODUCTS

2.1 SOFTWARE REQUIREMENTS

- A. The Owner's existing SCADA (Human-Machine Interface or HMI) software, including but not limited to all relevant displays, alarm summary pages, data collection, and historical trending/reporting, shall be modified to include all work performed under this Contract.
- B. The Owner's existing control system shall be modified to include the inputs and outputs specified in the Input/Output Schedule and in other Sections of this Division.
- C. The Owner existing HMI software is Rockwell's Factory Talk View SE Version 12, and Plant PAX version 3.0.

2.2 OVERALL SYSTEM CONFIGURATION

- A. All HMI software configuration performed under this Contract shall be coordinated with the Owner and shall match in all possible respects the "look and feel" of the Owner's existing system. Major HMI software scope of work shall include but shall not be limited to the following:
 - 1. Create new graphic displays showing the new facilities and functions described herein complete with all associated equipment and instrumentation.
 - 2. Modify the existing plant overview display(s) for the SCADA system to include the new facilities and equipment and create links to the new screens.
 - 3. Modify existing alarm summary pages to incorporate new monitoring data into the alarm displays.

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4. Modify existing reports to include the additional monitoring points specified under this Contract.
 5. Create new real-time and historical trends and coordinate with the Owner appropriate grouping of the trend charts.
 6. Update the system status display to include new hardware provided under this Contract.
- B. Ladder logic resident in existing PLCs shall be configured to perform the functions described as specified herein and in Specification Section 17950. Specifically, the existing PLCs shall be programmed to accept the inputs specified in the Input/Output Schedule and to make this data readily available to the plant network and shall be programmed to execute the logic necessary to implement all control functions associated with the scope of work specified under this Contract.
- C. All discrete and analog data acquisition, preprocessing, storage and process control functions shall be performed at the PLC level. The HMI software shall not be used for this purpose.

PART 3 -- EXECUTION

3.1 OVERALL SYSTEM CONFIGURATION

- A. The Owner's existing HMI software, including but not limited to all relevant displays, alarm summary pages, data collection, and historical trending/reporting, shall be modified to include all work performed under this Contract. The existing software is Rockwell PlantPax version 3.0.
- B. The Owner's existing control system shall be modified to include the inputs and outputs specified in the Input/Output Schedule and in other Sections of this Division.

3.2 SOFTWARE COMMUNICATIONS

- A. All HMI software configuration performed under this Contract shall be coordinated with the Owner and shall match in all possible respects the "look and feel," in the opinion of the Engineer, of the existing SCADA System. Specified features and functions of this Contract that do not already exist, even if only for "look and feel," shall be provided. Details on how to best implement these features and functions shall be discussed with Owner and Engineer.
- B. Major HMI software scope of work shall include, but shall not be limited to, the following:
1. Create new graphic displays showing the new facilities and functions described herein complete with all associated equipment and instrumentation.
 2. Modify the existing plant overview display(s) for the SCADA system to include the new facilities and equipment and create links to the new screens.
 3. Modify existing alarm summary pages to incorporate new monitoring data into the alarm displays.
 4. Modify existing reports to include the additional monitoring points specified under this Contract.
 5. Create new real-time and historical trends and coordinate with the Owner appropriate grouping of the trend charts.

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- 6. Update the system status display to include new hardware provided under this Contract.
- C. Ladder logic resident in existing PLCs shall be modified to perform the functions described as specified herein and in Section 17950 – Functional Control Descriptions. Specifically, the existing PLCs shall be programmed to accept the I/O specified in Section 17910 – Control System - Input/Output Schedule and to make this data readily available on the plant network and shall be programmed to execute the logic necessary to implement all control functions associated with the scope of work specified under this Contract.
- D. All discrete and analog data acquisition, preprocessing, storage and process control functions shall be performed at the PLC level. The HMI software shall not be used for this purpose.

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SECTION 17500

ENCLOSURES, GENERAL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the control enclosures, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.
- B. Control enclosures shall be assembled, wired, and tested in the instrumentation subcontractor's own facilities, unless specified otherwise. All components and all necessary accessories such as power supplies, conditioning equipment, mounting hardware, signal input and output terminal blocks, and plug strips that may be required to complete the system shall be provided.
- C. Either manufacturer's standard or custom enclosures may be furnished subject to the requirements of the Contract Documents and favorable review by the Owner.
- D. Due consideration shall be given to installation requirements for enclosures in new and existing structures. The Contractor shall examine plans and field inspect new and existing structures as required to determine installation requirements and shall coordinate the installation of all enclosures with the Owner and all affected contractors. The Contractor shall be responsible for all costs associated with installation of enclosures, including repair of damage to structures (incidental, accidental or unavoidable).
- E. The terms enclosure, cabinet, and panel shall be considered the same product and are used interchangeably

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17520 – Field Panels
- C. Section 17550 – Panel Instruments and Accessories
- D. Section 17560 – Surge Protection Devices
- E. Section 17600 – Instruments, General
- F. Refer to Division 16 for additional requirements for cable, circuit breakers, disconnect switches, etc.

1.3 GENERAL INFORMATION AND DESCRIPTION

- A. For locations inside buildings in areas other than climate controlled (i.e., heated and air conditioned) electrical or control rooms, panel shall be Type 316 stainless steel NEMA 4X

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construction, or as indicated for hazardous area classification (Class, Division, at a minimum), or submersible, NEMA 6, applications. Epoxy coated cast copper-free aluminum construction shall also be acceptable for NEMA 4, 6 and 7 applications.

- B. For locations in storage/feed areas for chlorine or other applicable corrosive chemicals, panel shall be of non-metallic construction, rated NEMA 4X, and be fully compatible with the associated chemical.
- C. For locations within climate controlled (i.e., heated and air-conditioned) electrical or control rooms, panel shall be a painted steel fully enclosed NEMA 12 units with gasketed doors.
- D. For outdoor locations, panel shall be Type 316L stainless steel NEMA 4X construction unless located in chlorine environments. Chlorine environment shall be nonmetallic NEMA 4X construction.

1.4 TOOLS, SUPPLIES AND SPARE PARTS

- A. Tools, supplies and spare parts shall be provided as specified in Section 17050 - Tools, Supplies and Spare Parts. In addition, the spare parts items shall be provided as specified in the individual cabinet and panel specification sections.

PART 2 -- PRODUCTS

2.1 CABINETS AND PANELS

- A. Cabinets and panels shall be formed or welded construction, reinforced with Unistrut, Powerstrut, or equal to facilitate mounting of internal components or equipment. Sufficient access plates and doors shall be provided to facilitate maintenance and testing of the cabinet's equipment. Doors shall be removable. Cabinets and panels with any dimension 36 inches or greater shall be provided with removable lifting lugs designed to facilitate safe moving and lifting of the panel during installation. All doors shall be fitted with common-keyed locks.
- B. Cabinets and panels shall be minimum 14 USS gauge. Cabinets and panels with any dimension greater than 36 inches shall be 12 USS gauge.
- C. Cabinets and panels shall have doors on the front and shall be designed for front access. NEMA 12 cabinets shall be fitted with three-point door latches. Doors for NEMA 4X cabinets shall be all stainless steel with three-point latches. Door hardware on NEMA 4X cabinets located in chemical storage/feed areas shall be non-corrosive in that environment.
- D. Panels and cabinets located outside fence-secured areas shall be fitted with padlockable latch kits. Coordinate keying with Owner.
- E. All cabinets and panels shall be provided with drawing pockets for as-built panel drawings. One copy of the appropriate panel as-built drawings shall be furnished and left in the pocket of each panel.
- F. Panels with any dimension greater than 36 inches that contain a programmable controller (PLC) shall be provided with a folding laptop programmer shelf on the inside of the door.

When deployed, the laptop shelf shall not be greater than 48 inches above finished floor. Laptop shelf shall be fitted to door with factory applied weld-studs. Weld discoloration and enclosure penetrations will not be accepted.

- G. Unless otherwise noted, panel-mounted control devices (OIUs, hand switches, etc.) requiring operator access shall be mounted between 48 and 60 inches above the floor or work platform.
- H. Cabinets and panels shall be prefabricated cabinets and panels by Hoffman or Saginaw Control and Engineering (SCE). The Contractor may optionally provide cabinets that are custom-fabricated by the instrumentation subcontractor or by a reputable panel fabrication shop acceptable to the Engineer.

2.2 TERMINAL BLOCKS

- A. Terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails securely bolted to the cabinet subpanel. Terminals shall be of the screw down pressure plate type as manufactured by Phoenix Contact, Weidmuller, Wieland, Square D, or equal.
- B. Power terminal blocks for both 120 VAC and 24 VDC power shall be single tier with a minimum rating of 600 volts, 30 amps.
- C. Signal terminal blocks shall be single tier with a minimum rating of 600 volts, 20 amps.

2.3 NAMEPLATES

- A. Items of equipment installed in control panels shall be identified with nameplates. Each nameplate shall be located so that it is readable from the normal observation position and is clearly associated with the device or devices it identifies. Nameplates shall be positioned so that removal of the device for maintenance and repair shall not disturb the nameplate. Nameplates shall include, as necessary, the equipment identification number, description, calibrated range, and set point(s). Abbreviations of the description shall be subject to the Engineer's approval.
- B. Nameplates shall be made of 1/16-inch thick machine engraved laminated phenolic plastic having white numbers and letters not less than 3/16-inch high on a black background. Nameplates attached to instruments may be black laser etched 1/8-inch high text on stainless steel with sharp edges made smooth. Stamped text shall not be acceptable.
- C. Nameplates shall be attached to metal equipment by NEMA rated stainless steel screws and to other surfaces by an epoxy-based adhesive that is resistant to oil and moisture. In cases where the label cannot be attached by the above methods, it shall be drilled and attached to the associated device by means of a braided stainless steel wire affixed with a permanent crimp.
- D. Submit sample nameplate of each type.

PART 3 -- EXECUTION

3.1 FABRICATION

- A. The cabinet itself and all interior and exterior equipment shall be identified with nameplates. The equipment shall be mounted such that service can occur without removal of other equipment. Face mounted equipment shall be flush or semi-flush mounted with flat black escutcheons. All equipment shall be accessible such that adjustments can be made while the equipment is in service and operating. All enclosures shall fit within the allocated space as shown on the Drawings.
- B. Enclosures shall provide mounting for power supplies, control equipment, input/output subsystems, panel-mounted equipment and appurtenances. Ample space shall be provided between equipment to facilitate servicing and cooling.
- C. Enclosures shall be sized to adequately dissipate heat generated by equipment mounted inside the panel. If required, one or more of the following shall be provided to facilitate cooling:
 - 1. For NEMA 12 cabinets only, louvered openings near the bottom and top or thermostatically controlled, low-noise cooling fans to circulate outside air into the enclosure, exhausting through louvers near the top of the cabinet. Air velocities through the enclosure shall be minimized to assure quiet operation.
 - 2. Thermostatically controlled, low noise internal air blowers to circulate air within the enclosure, maintaining a uniform internal temperature. Initial setpoint shall be 75 degrees F.
 - 3. All intake openings in cabinets and panels shall be fitted with dust filters.
- D. Enclosures shall be constructed so that no screws or bolt heads are visible when viewed from the front. Punch cutouts for instruments and other devices shall be cut, punched, or drilled and smoothly finished with rounded edges.
- E. The temperature inside each enclosure containing digital hardware (e.g., PLC, computer, Ethernet switch) shall be continuously monitored and shall generate an alarm to the nearest PLC if the temperature rises to an adjustable, preset high temperature. This thermostat shall be independent and separate from the thermostat used to control the temperature in the enclosure described above. Enclosure "high interior temperature" alarm shall be displayed on the HMI or OIT.
- F. Intrusion alarm switches shall be provided on all enclosures containing digital hardware and shall generate an alarm to the nearest PLC when any enclosure door is opened. If panel contains a service light, alarm switch shall also be wired to turn light on when door is opened.
- G. Terminals shall be marked with a permanent, continuous marking strip. One side of each terminal shall be reserved exclusively for field incoming conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal. Subject to the approval of the Engineer, a vendor's pre-engineered and prefabricated wiring termination system will be acceptable.
- H. Wiring within cabinets, panels, and consoles shall be installed neatly and shall comply with accepted standard instrumentation and electrical practices. Power, control and signal wiring shall comply with Division 26 of the Specifications, except that the minimum wire size for

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discrete signal wiring may be 16 AWG, and for analog wiring may be 18 AWG. For each pair of parallel terminal blocks, the field wiring shall be between the blocks.

- I. Separate terminal strips shall be provided for each type of power and signal used within each cabinet. Where applicable, terminal strips for different voltages of discrete signal wiring shall also be separated. Terminal strips shall be labeled as to voltage and function.
- J. All wiring shall be bundled and run open or enclosed in vented plastic wireway as required. Wireways shall be oversized by a minimum of 10%; overfilled wireways shall not be acceptable. All conductors run open shall be bundled and bound at regular intervals, not exceeding 12 inches, with nylon cable ties. Care shall be taken to separate electronic signal, discrete signal, and power wiring when operating at differing voltages.
- K. Spare field wiring shall be bundled, tied, and labeled as specified above, and shall be neatly coiled in the bottom of the cabinet.
- L. All installed spare I/O hardware shall be wired along with live I/O wiring to the field wiring terminal blocks within the cabinet. Where space for spare I/O modules has been provided with the PLC backplane or DIN-rail mounting system, corresponding space for wiring, surge protection, and terminations shall be furnished within the cabinet.
- M. A copper ground bus shall be installed in each cabinet and shall be connected to the building power ground.
- N. Interior panel wiring shall be tagged at all terminations with machine-printed self-laminating labels. Labeling system shall be Brady TLS 2200 Printer with TLS 2200®/TLS PC Link™ labels, or equivalent system by Seton or Panduit. The wire numbering system and identification tags shall be as specified in Section 16123 - Building Wire and Cable. Field wiring terminating in panels shall be labeled in accordance with the requirements of Section 16123 - Building Wire and Cable. Where applicable, the wire number shall be the ID number listed in the input/output schedules.
- O. Wires shall be color coded as follows:
 - 1. Equipment Ground – GREEN
 - 2. 120 VAC Power – BLACK
 - 3. 120 VAC Power Neutral – WHITE
 - 4. 120 VAC Control (Internally Powered) – RED
 - 5. 120 VAC Control (Externally Powered) – YELLOW
 - 6. 24 VAC Control – ORANGE
 - 7. DC Power (+) – RED
 - 8. DC Power (-) – BLACK
 - 9. DC Control – BLUE
 - 10. Analog Signal – BLACK/WHITE or BLACK/RED
- P. Enclosures shall be provided with a main circuit breaker and a circuit breaker on each individual branch circuit distributed from the panel. Main breaker and branch breaker sizes shall be coordinated such that an overload in a circuit will trip only its immediate breaker and not the upstream breaker.

- Q. Enclosures with any dimension larger than 36 inches shall be provided with 120-volt duplex receptacles for service equipment and LED service lights. Power to these devices shall be independent from the PLC power supply and its associated uninterruptible power system.
- R. Where applicable, enclosures shall be furnished with red laminated plastic warning signs in each section. The sign shall be inscribed "WARNING - This Device Is Connected to Multiple Sources of Power." Letters in the word "WARNING" shall be 0.75 inch high, white.
- S. The interconnection between equipment and panel shall be by means of flexible cables provided to permit withdrawal of the equipment from the cabinet without disconnecting the plugs.

3.2 PAINTING/FINISHING

- A. All steel enclosures shall be free from dirt, grease, and burrs and shall be treated with a phosphatizing metal conditioner before painting. All surfaces shall be filled, sanded, and finish coated by spraying a 1-2 mil epoxy prime coat and smooth, level, high grade textured finish between flat and semi-gloss shine. The colors shall be selected by the Owner from a minimum of six color samples provided. Refer to Division 9 for additional requirements.
- B. Materials and techniques shall be of types specifically designed to produce a finish of superior quality with respect to adherence, as well as impact and corrosion resistance.
- C. Panels fabricated from stainless steel shall not be painted.
- D. Panels fabricated from non-metallic materials (e.g., FRP) shall be gel-coated and shall not be painted.

3.3 INSTALLATION

- A. Refer to Section 17000 for additional requirements.

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SECTION 17520

FIELD PANELS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the field panels, with all spare parts, accessories, and appurtenances as specified or shown.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17500 – Enclosures, General

PART 2 -- PRODUCTS

2.1 FIELD PANELS

- A. Field panels for outdoor service shall be suitable for wall or pipe mounting. Panels shall have the following features:
 - 1. Type 316L stainless steel NEMA 4X construction unless located in chlorine environments. Chlorine environment shall be nonmetallic NEMA 4X construction.
 - 2. Hinged and foamed-in-place continuous gasketed door(s). Door material shall match enclosure and shall have piano hinge(s) and three-point latches.
 - 3. Field panels located outside fence-secured areas shall be fitted with staple and hasp. Provide padlock and coordinate keying with Owner.
 - 4. Thermal insulation and thermostatically controlled space heaters where required to prevent condensation or maintain environmental conditions for installed components.
 - 5. External sun shields or shades constructed of the same materials as the associated enclosure, unless otherwise specified. Sun shield or shade shall be fitted to enclosure supports and not to enclosure. Sun shield or shade shall have a slightly sloped top to shed water and shall extend past the front of the enclosure by at least 6 inches and extend down the side and back of enclosure.
- B. All external sample/process piping, including valves and appurtenances, shall be insulated with weather-proof insulation and heat-taped to prevent freezing. Heat taping shall be thermostatically controlled and self-regulating and shall adjust its heat output to the temperature of the lines. Heat tape shall be powered from a GFCI circuit from within panel, unless otherwise shown or specified.
- C. Field panels shall be adequately sized to house instruments, power supplies, surge protection, and appurtenant equipment required for operation. Sufficient space shall be provided for servicing instruments without removal of equipment from the enclosure.

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- D. Field panels shall be as manufactured by Hoffman, Saginaw Control and Engineering (SCE), or equal.

PART 3 -- EXECUTION

3.1 REQUIREMENTS

- A. Refer to Section 17500 for additional requirements.

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SECTION 17550

PANEL INSTRUMENTS AND ACCESSORIES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the panel instruments and accessories, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17500 – Enclosures, General

1.3 GENERAL INFORMATION AND DESCRIPTION

- A. All equipment mounted on the face of a panel shall conform to the same NEMA rating specified for the panel construction.

1.4 TOOLS, SUPPLIES AND SPARE PARTS

- A. Tools, supplies and spare parts shall be provided as specified in Section 17050 - Tools, Supplies and Spare Parts. In addition, the following specific spare parts items shall be provided:
 - 1. One of each type of panel mounted equipment (i.e., indicators, signal converters, etc.) provided under this Contract.
 - 2. Five of each type of interposing relay provided under this Contract.

PART 2 -- PRODUCTS

2.1 ELECTRONIC INDICATORS

- A. Electronic indicators shall be 3.5 or 6 digit, as appropriate, with 0.56" high red LED display. Indicators shall be provided with nameplate and scale calibrated to match the calibration of the primary element. The unit shall be designed primarily for use with 4-20 mA current loop signal circuits. Indicator operating voltage shall be 115 VAC 10%, 60 Hz. Indicator controls shall include three (3) front-panel pushbuttons for modifying alarm values and other indicator setup. Two (2) form-C relays shall be provided for each indicator. Relay contact outputs shall be rated 5A, 120/240 VAC, resistive load. Where required, a regulated and isolated 24 V excitation power supply shall be provided. Indicators shall be suitable for indoor or outdoor service as required and shall have the same NEMA enclosure rating as the associated enclosure. Indicators shall be Red Lion Model IMP or APLCL, or equal.

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2.2 SIGNAL CONVERTERS

- A. Signal converters shall be provided as required to provide control functions and to interface instrumentation and controls, equipment panels, motor control centers and other instrumentation and controls supplied under other Divisions to the controls provided herein.
- B. General Requirements – Converters shall be of the miniature type, utilizing all solid-state circuitry suitable for mounting within new or existing cabinetry. Where sufficient cabinet space is not available, sub panels or supplemental enclosures shall be provided. Power supply shall be 120V, 60 hertz where required by the converter. Repeatability shall be 0.1% of span, deadband shall be 0.1% span, maximum. Where specific converters are not listed, but are required to interface with the process control system, they shall comply with the general requirements stated herein.
- C. Current to Current Isolators – Current to current isolators shall be furnished where necessary to provide an isolated current loop, calculations or signal amplification between the plant process control system and instrumentation and control loops. Isolators shall be sized such that resistance of existing loops shall not exceed maximum rated resistance. Isolators shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.
- D. Voltage to Current Transducers – Voltage to current (or current to voltage) transducers shall convert a voltage signal of one magnitude to a 4 20 milliamp DC current signal. The output current shall be directly proportional to the input signal voltage. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.
- E. Integrators – Integrators shall be provided as interchangeable plug in modules with zero and span adjustment available on the front plate of the units. Output shall range from 0 to 0.1 through 0 to 10 pulses per second. Accuracy shall be + 0.1% of input span. Integrators shall convert linear analog signals to pulse rate and provide a solid state output. Integrators shall be as manufactured by AGM Electronics, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.
- F. Electronic Switches (Alarm Relays) – Electronic switches shall be furnished with a calibrated dial for adjusting set points. The input to the switch shall be 4 20 mADC, and the set point shall be adjustable over the full range. Unless otherwise noted, the dead band shall be fixed at less than 2 percent of span. The set point stability shall be +0.1% per degree F. The repeatability shall be +0.1% of span. The units shall be furnished with SPDT relays rated at 10 amperes at 115 VAC. Electronic switches shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.
- G. RTD to Current Signal Converters – RTD to current signal converters shall convert a 3-wire RTD input signal to an isolated 4 20 mADC output signal. Each converter shall operate from a 120 VAC power source. Accuracy shall be 0.10 percent of span or better. Calibrated span of each converter shall be as indicated on the instrument list. The Contractor shall coordinate calibration of the signal converters with existing RTD elements. The signal converters shall be furnished in the manufacturer's standard enclosure for installation in an existing indoor

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electrical cabinet. Signal converters shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

- H. Interposing Relays – Where required to interface between motor control centers, equipment controls, and control panels, interposing relays and associated control wiring circuitry shall be furnished and installed to provide the monitoring and/or control functions specified herein. Interposing relays shall be small format type, DPDT, minimum 10-amp, 120 VAC contact rating. Relay coils shall be 120 VAC or 24 VDC as required. Relays shall have a flag indicator to show relay status, a pushbutton to allow manual operation of the relay, and an internal pilot light to indicate power to the coil. Relays shall be as manufactured by Square D, Potter & Brumfield, Allen-Bradley, or equal.
- I. Timing Relays – Timing Relays (TR) shall be the general-purpose plug-in type, Type JCK as manufactured by Square D Company, Cutler-Hammer/Westinghouse Electric Corporation equivalent, Allen-Bradley equivalent, or equal. Timing relays shall be electronic type with 120 VAC coils unless otherwise specified or indicated on the Drawings. Timers shall be provided with a minimum of two SPDT timed output contacts and instantaneous contacts where required. Contact ratings shall be the same as for interposing relays as specified above.
- J. Intrinsically Safe Relays and Barriers – Intrinsically safe relays and barriers shall be provided where required to interface with equipment such as float level switches that are located in NFPA-classified hazardous areas. Intrinsically safe relays and barriers shall be FM approved and shall be manufactured by Pepperl and Fuchs, Crouse Hinds, Square D, or equal.

2.3 TOTALIZERS

- A. Totalizing counters shall be provided for flush panel, spring clip mounting. Face dimensions of the totalizing counters shall be no larger than 1 1/8 inches high by 2 inches wide. Totalizing counters shall contain eight digits. Height of the digits shall not be less than 5/32 inch. Numerals shall be white on a black background. The counter shall be non-resettable and shall be totally compatible for operation on the pulses supplied by the associated instrument or integrator. The totalizing counter shall be capable of a maximum count rate of 25 counts/second.
- B. Legend plates shall be provided for each of the totalizing counters with white letters on a black background with legends as specified below.
- C. Totalizing counters shall be manufactured by Kessler Ellis, or equal.

2.4 ACCESSORIES

- A. Control operators such as pushbuttons (PB), selector switches (SS), and pilot lights (PL) shall be Cutler-Hammer/Westinghouse Type E34, Square D Company Type SK, or equal. Control operators shall be 30.5 mm, round, heavy duty, oil tight NEMA 4X corrosion resistant.
- B. Pushbuttons shall be non-illuminated, spring release type. Pushbuttons shall include a full guard. Panic stop/alarm pushbuttons shall be red mushroom type with manual-pull release. Selector switches shall be non-illuminated, maintained contact type. Pilot lights shall be of the proper control voltage, push-to-test LED type with light lens colors as specified below.

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<u>Color</u>	<u>Function</u>
Red	Running (Open)
Green	Stopped or Off (Closed)
Amber	Fault
White	Other

- C. Control operators shall have legend plates as specified herein, indicated on the Drawings, or otherwise directed by the Engineer. Legend plates shall be plastic, black field (background) with white lettering. Engraved nameplates shall be securely fastened above each control operator. If adequate space is not available, the nameplate shall be mounted below the operator.
- D. Control operators for all equipment shall be as specified herein and of the same type and manufacturer unless otherwise specified or indicated on the Drawings.
- E. Alarm horns shall be general-purpose type, panel-mounted, and shall be suitable for indoor or weatherproof service, as required. Power supply shall be either 115 VAC or 24 VDC. Horns shall be capable of producing 100 dB at 10 feet and shall have adjustable volume. Horns shall be Vibratone series as manufactured by Federal Signal Corporation, McMaster-Carr equivalent, Edwards Signaling Company equivalent, or equal.

PART 3 -- EXECUTION

3.1 REQUIREMENTS

- A. Refer to Section 17500 for additional requirements.

END OF SECTION

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SECTION 17560
SURGE PROTECTION DEVICES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, install and place in satisfactory operation the surge protection devices (SPDs) as specified herein and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17500 – Enclosures, General

1.3 GENERAL INFORMATION AND DESCRIPTION

- A. All surge protectors of each type provided under this Contract shall be furnished by a single manufacturer.

1.4 TOOLS, SUPPLIES AND SPARE PARTS

- A. Tools, supplies and spare parts shall be provided as specified in Section 17050 - Tools, Supplies and Spare Parts. In addition, the following specific spare parts items shall be provided:
 - 1. Five of each type of surge protection device provided under this Contract.

PART 2 -- PRODUCTS

2.1 SURGE PROTECTION, GENERAL

- A. All electrical and electronic elements shall be protected against damage due to electrical transients induced in interconnecting lines from lightning discharges and nearby electrical systems.
- B. Manufacturer's Requirements: All surge protection devices shall be manufactured by a company that has been engaged in the design, development, and manufacture of such devices for at least 5 years. Acceptable manufacturers shall be Phoenix Contact, Edco, Transtector, Weidmuller, or equal.
- C. Surge protection device installations shall comply with UL 94, the National Electric Code (NEC), and all applicable local codes.
- D. Surge protection devices shall be installed as close to the equipment to be protected as practically possible.

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- E. Device Locations: As a minimum, provide surge protection devices at the following locations:
1. At any connections between ac power and electrical and electronic equipment, including panels, assemblies, and field mounted analog transmitters.
 2. At both ends of all analog signal circuits that have any portion of the circuit extending outside of a protecting building.
 3. At both ends of all copper-based communication cables which extend outside of a building, including at field instruments and the field side of analog valve position signals.
 4. On all external telephone communication lines.

2.2 AC POWER PROTECTION

- A. Surge protection device assemblies for connections to AC power supply circuits shall:
1. Be provided with two 3-terminal barrier terminal strips capable of accepting No. 12 AWG solids or stranded copper wire. One terminal strip shall be located on each end of the unit.
 2. Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements. The surge protection device shall be provided with provisions for mounting to interior of equipment racks, cabinets, or to the exterior of freestanding equipment.
 3. Be constructed as multistage devices consisting of gas tube arrestors, high energy metal oxide varistors, or silicon avalanche suppression diodes. Assemblies shall automatically recover from surge events, and shall have status indication lights.
 4. Comply with all requirements of UL 1449, latest edition.
 5. Be able to withstand a peak surge current of 10,000 amps based on a test surge waveform with an 8-microsecond rise time and a 20-microsecond exponential decay time, as defined in UL 1449.
 6. Have the following characteristics:
 - a. Maximum Continuous Operating Voltage: 150VAC
 - b. Maximum Operating Current: 20 amps
 - c. Ambient Temperature Range: -20 degrees C to +65 degrees C
 - d. Response Time: 5 nanoseconds

2.3 ANALOG SIGNAL CIRCUIT PROTECTION

- A. Surge protection device assemblies for analog signal circuits shall:
1. Have four lead devices with DIN Rail mounting.
 2. Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements.
 3. Be constructed as multistage devices consisting of gas tube arrestors and silicon avalanche suppression diodes. Gas tube arrestors and diodes shall be separated by a series impedance of no more than 20 ohms. Assemblies shall automatically recover from surge events.
 4. Comply with all requirements of UL 497B.
 5. Be able to withstand a peak surge current of 10,000 amps based on a test surge waveform with an 8-microsecond rise time and a 20-microsecond exponential decay time, as defined in UL 1449.
 6. Limit line-to-line voltage to 40 volts on 24VDC circuits.
 7. Have the following characteristics:

- a. Maximum Continuous Operating Voltage: 28VDC
- b. Ambient Temperature Range: -20 degrees C to +65 degrees C
- c. Response Time (Line-to-Line): 5 ns

2.4 COMMUNICATION CIRCUIT PROTECTION

- A. Surge protection devices for copper-based data communication circuits shall:
1. Be designed for the specific data communication media and protocol to be protected (i.e. telephone, serial, parallel, network, data highway, coax, twinaxial, twisted pair, RF, etc.).
 2. Provide protection of equipment to within the equipment's surge withstand levels for applicable standard test wave forms of the following standards:
 - a. IEC 60-1 / DIN VDE 0432 part 2
 - b. CCITT K17 / DIN VDE 0845 part 2
 - c. IEEE C62.31
 3. Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements.
 4. Provide automatic recovery.

PART 3 -- EXECUTION

3.1 REQUIREMENTS

- A. Refer to Section 17500 for additional requirements.

END OF SECTION

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SECTION 17600
INSTRUMENTS, GENERAL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The instrumentation subcontractor shall furnish, install, test and place in operation instruments as scheduled together with all signal converters, transmitters, isolators, amplifiers, etc. to interface with the process control system as shown on the Drawings and as specified. The Contractor may elect to install sensors on process lines provided that the instrumentation subcontractor provides full on-site supervision during installation. Mounting of associated indicators, sensors, sampling pumps, power supplies, brackets and appurtenances shall be provided as indicated.
- B. It is the intent of the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract. The Instrumentation Subcontractor shall supervise installation of equipment provided where installation is by other Subcontractors or Contractors.
- C. Tapping and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. The Contractor shall ensure that the location, supports, orientation and dimensions of the connections and tapping for instruments are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 –Control and Information System Scope and General Requirements
- B. Section 17698 – Instrumentation and Control System Accessories
- C. Instruments furnished with mechanical equipment shall be furnished, installed, tested and calibrated as specified elsewhere in the Contract Documents.

1.3 TOOLS, SUPPLIES AND SPARE PARTS

- A. Tools, supplies and spare parts shall be provided as specified in Section 17050 - Tools, Supplies, and Spare Parts - General.
- B. Additional items as recommended by the analytical instrument manufacturers or as described for the specified analytical instrument sections shall be provided.

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PART 2 -- PRODUCTS

2.01 GENERAL

- A. All instrumentation supplied shall be the manufacturer's latest design. Unless otherwise specified, instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Microprocessor-based equipment shall be supplied unless otherwise specified. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings, or as required.
- B. Equipment installed in a hazardous area shall meet or exceed Class, Group, and Division requirements as shown on the Drawings, to comply with the National Electrical Code.
- C. All field instrumentation for outdoor service shall be provided with enclosures that are suitable for outdoor service, as follows:
 - 1. Where the manufacturer's enclosures are suitable for outdoor service, they shall be provided with instrument sunshades. Sunshades shall be Style E as manufactured by O'Brien Corporation, or equal. Where possible, these instruments shall be mounted in a north facing direction.
 - 2. Where the manufacturer's standard enclosures are not suitable for outdoor service, instruments shall be mounted in Field Panels in accordance with Section 17520 – Field Panels or may be furnished with Vipak instrument field enclosures as manufactured by O'Brien Corporation, equivalent by Intertec, or equal. It shall not be necessary to provide the manufacturer's NEMA 4 or 4X enclosures for instruments that will be subsequently mounted in separate field panels.
- D. All instruments shall return to accurate measurement without manual resetting upon restoration of power after a power failure.
- E. Unless otherwise shown or specified, local indicators shall be provided for all instruments. Where instruments are located in inaccessible locations, local indicators shall be provided and shall be mounted as specified in Paragraph 3.01 B herein. All indicator readouts shall be linear in process units. Readouts of 0 to 100% shall not be acceptable (except for speed and valve position). Isolated outputs shall be provided for all transmitters.
- F. Unless otherwise specified, field instrument and power supply enclosures shall be Type 316 stainless steel, fiberglass (or similar, per Engineer's judgement) or PVC coated copper-free cast aluminum NEMA 4X construction.
- G. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by the associated equipment manufacturer.
- H. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture and fungus. Solid state components shall be conservatively rated for long term performance and dependability over ambient atmosphere fluctuations. Ambient conditions shall be -20 to 50 degrees C and 20 to 100 percent relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid, and corrosive service conditions.

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- I. All devices furnished hereunder shall be heavy duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production. All equipment provided, where applicable, shall be of modular construction and shall be capable of field expansion.
- J. All non-loop-powered instruments and equipment shall be designed to operate on a 60 Hz AC power source at a nominal 117 V, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.
- K. All analog transmitter and controller outputs shall be isolated, 4 to 20 milliamps into a load of 0 to 750 ohms, unless specifically noted otherwise. All switches shall have double pole, double throw contacts rated at a minimum of 600 VA, unless specified otherwise.
- L. Materials and equipment used shall be UL approved wherever such approved equipment and materials are available.

2.2 ANALYTICAL INSTRUMENTS

- A. Liquid samples shall not pass through housings containing analyzer electronics. Process fluid temperature will be within a range of 40 to 90 degrees F.
- B. Where ambient temperatures will affect accuracy by more than 1 percent of span, a suitable isothermal enclosure with thermostatically controlled space heater shall be provided.
- C. Sample assemblies shall be suitable for submersion or flow-through service as noted and shall be chemically inert to constituents of raw wastewater solids or other chemical environment, as scheduled. Where the sample is drawn prior to filtration, the sample assemblies shall be capable of handling solids and grease.
- D. Each analyzer requiring reagents or other replaceable parts shall be furnished with sufficient chemicals and replaceable parts for startup and acceptance tests and the specified warranty period.
- E. Contractor's submittals on these analyzers shall include information on monthly reagent consumption and a list of replaceable parts required for periodic maintenance and the recommended operating periods between replacements. Installation of analyzers and sample preparation shall be in accordance with the analyzer manufacturer's instructions.
- F. Analysis instrumentation performance, accuracy and reproducibility shall be as prescribed in APHA/AWWA/WEF "Standard Methods for the Examination of Water and Wastewater", latest edition. For those measurements specified herein, for which performance characteristics are not listed in the above, the supplier shall state instrument performance characteristics. The "referee" method shall be as prescribed in EPA Methods for Chemical Analysis of Water and Wastes (1971).

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PART 3 -- EXECUTION

3.1 INSTALLATION

A. General

1. Equipment shall be located so that it is accessible for operation and maintenance. The instrumentation subcontractor shall examine the Drawings and shop drawings for various items of equipment in order to determine the best arrangement for the work as a whole and shall supervise the installation of process instrumentation supplied under this Division.
2. Work shall be performed in compliance with all applicable local codes and practices. Where the Contract Documents do not delineate precise installation procedures, the latest version of the American Petroleum Institute (API) Recommended Practice 551 manual (API RP 551) shall be used as a guide to installation procedures.

B. Equipment Mounting and Support

1. Field equipment shall be wall mounted or mounted on two inch diameter pipe stands welded to a 10 inch square by 1/2 inch thick base plate unless shown adjacent to a wall or otherwise noted. Materials of construction shall be aluminum or 316 stainless steel. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than 1/2 inch by use of phenolic spacers. Expansion anchors in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.
2. Embedded pipe supports and sleeves shall be Schedule 40, Type 316 stainless steel pipe, ASA B 36.19, with stainless steel blind flange for equipment mounting, unless otherwise indicated.
3. Materials for miscellaneous mounting brackets and supports shall be Type 316 stainless steel construction.
4. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 5 of the specifications.
5. Transmitters shall be oriented such that output indicators are readily visible.

C. Control and Signal Wiring

1. Electrical, control and signal wiring connections to transmitters and elements mounted on process piping or equipment shall be made through liquid tight flexible conduit. Conduit seals shall be provided where conduits enter all field instrument enclosures and all cabinetry housing electrical or electronic equipment.

3.2 ADJUSTMENT AND CLEANING

- A. The instrumentation subcontractor shall comply with the requirements of Division 1 of these Specifications and all instrumentation and control system tests, inspection, and calibration requirements for all instrumentation and controls provided under this Contract and specified herein. The Engineer, or his/her designated representative(s), reserves the right to witness any test, inspection, calibration or start up activity. Acceptance by the Engineer of plans, reports, or documentation relating to testing or commissioning activity shall not relieve the Contractor of his/her responsibility for meeting all specified requirements.

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- B. The instrumentation subcontractor shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Instruments which fails to meet Contract requirements, or published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.
- C. At least 60 days before the anticipated initiation of installation testing, the Contractor shall submit to the Engineer a detailed description of the installation test(s) to be conducted to demonstrate the correct operation of the instrumentation supplied hereunder.
- D. Field instrument calibration shall conform to the following requirements:
1. The instrumentation subcontractor shall provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate or verify factory calibration of each instrument supplied under this Contract and existing instruments shown to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration. Calibration and verification shall take place under actual process conditions. Forcing outputs shall not be acceptable.
 2. Each instrument shall be calibrated/verified at 0, 25, 50, 75 and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracy's as set forth by the National Institute for Standards and Technology (NIST).
 3. The instrumentation subcontractor shall provide a written calibration/verification sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, brief description of how the calibration process was performed, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made. For electronic or powered instruments, the calibration/verification sheet shall also list all configurable parameters that have been modified from their default factory setting.
 4. If doubt exists as to the correct method for calibrating or checking the calibration/verification of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.
 5. Upon completion of calibration, devices calibrated hereunder shall not be subjected to adjustments, sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to over-voltages, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and re-calibrated/verified at no cost to the Owner. Equipment that has been adjusted, modified, or moved or there is evidence of such activity shall be re-calibrated/verified at no cost to the Owner.
 6. After completion of instrumentation installation, the instrumentation subcontractor shall perform a loop check. The Contractor shall submit final loop test results with all

instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test.

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SECTION 17635

ROTAMETERS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation all variable area flow meters (i.e., rotameters), with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17600 – Instruments, General

PART 2 -- PRODUCTS

2.1 ROTAMETERS

- A. Variable area flow meter shall consist of a float chamber, tapered float, and a measuring ring.
- B. Variable Area Flow Meters shall have the following specifications:
 - 1. Process Fluid Temperature: 32 to 140 degrees F
 - 2. Accuracy: +/- 2.0% of full scale
 - 3. Repeatability: 0.5% of full scale
 - 4. Max. Process Fluid Pressure: 200 psig at 140 degrees F
- C. The body material shall be Type 316 stainless steel. Wetted parts shall be as follows:
 - 1. Float: Type 316 stainless steel minimum; or compatible with process fluid
 - 2. Glass Tube: Borosilicate glass
 - 3. O-Rings: Viton minimum; or compatible with process fluid
 - 4. Others: Compatible with process fluid
- D. A graduated metal scale plate shall be provided for flow indication. A graduated metal scale plate shall be provided for flow indication. The indicator shall be large, easy to read, and calibrated in gallons per minute.
- E. Attachment to the pipe shall be by ANSI Class 125/150 stainless steel flanges conforming to ANSI B16.5.
- F. Rotameter shall have an integral needle or globe valve for adjustment of flow rate. Where the selected manufacturer does not provide this option, an externally mounted globe valve will be acceptable. For line sizes 1/2" and smaller, provide needle valve.

- G. Variable area flow meters shall be as manufactured by Brooks, Fischer & Porter, King Instruments, or equal.

PART 3 -- EXECUTION

3.1 REQUIREMENTS

- A. Refer to Section 17600 – Instruments, General

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SECTION 17650
PRESSURE GAUGES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the pressure gauges, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17600 – Instruments, General
- C. Section 17698 – Instrumentation Accessories

PART 2 -- PRODUCTS

2.1 PRESSURE GAUGES

- A. All gauges shall be designed in accordance with the ASME B40.1 entitled, "Gauges, Pressure, Indicating Dial Type - Elastic Element".
- B. All gauges shall be direct reading type. Snubbers shall be provided on all gauges. Gauge full-scale pressure range shall be selected such that the maximum operating pressure shall not exceed approximately 75% of the full-scale range.
- C. Features
 1. Mounting: ½" NPT, lower stem mount type
 2. Accuracy: 0.5% full scale
 3. Case: Solid front, black phenolic material
 4. Dial: White background and black letters
 5. Glass: Shatterproof
 6. Blow-out protection: Back
 7. Pressure element: stainless steel bourdon tube
 8. Movement: Stainless steel, Teflon coated pinion gear and segment
 9. Gaskets: Buna-N
- D. Liquid-filled or equivalent mechanically-damped gauges shall be used if the gauges are installed with pumps, or where gauges are subjected to vibrations or pulsation. Filling fluid shall be silicone unless oxidizing agents such as sodium hypochlorite are present, where halocarbon shall be used.

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- E. Gauge size shall be 4-1/2".
- F. Diaphragm seals and isolating ring seals shall be furnished in accordance with the requirements specified Section 17698 - Instrumentation and Control System Accessories.
- G. The complete gauge assembly and appurtenances shall be fully assembled and tested prior to field mounting. A 1/2" isolation stainless steel ball valve shall be provided for each gauge assembly.
- H. Pressure and vacuum gauges shall be Ashcroft Duragauge Model 1279, Ametek-U.S. Gauge Division, H.O. Trerice Co., WIKA Instrument Corporation, or equal.

PART 3 -- EXECUTION

3.1 REQUIREMENTS

- A. Refer to Section 17600 – Instruments, General.

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SECTION 17670

LEVEL SWITCHES (SUSPENDED FLOAT TYPE)

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the float level switches, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17600 – Instruments, General

PART 2 -- PRODUCTS

2.1 LEVEL SWITCHES (SUSPENDED FLOAT TYPE)

- A. Level switches of the direct acting float operated design shall be comprised of a hermetically sealed, approximately 5-inch diameter plastic casing float, containing microswitches and flexibly supported by means of a heavy neoprene or PVC jacket, with three-conductor cable a minimum of 20 feet in length. Unless otherwise specified, media specific gravity is 0.95 to 1.05. Microswitches shall be one normally open and one normally closed, 5A 115V AC capacity. Float hangers and supports shall be provided as shown on the installation detail drawings.
- B. Float switches shall be Model ENM as manufactured by Flygt, or equal.

PART 3 -- EXECUTION

3.1 REQUIREMENTS

- A. Refer to Section 17600 – Instruments, General.

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SECTION 17675
PRESSURE SWITCHES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the pressure switches, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 - Control and Information System Scope and General Requirements
- B. Section 17600 - Instruments, General

PART 2 -- PRODUCTS

2.1 PRESSURE SWITCHES

- A. Pressure, vacuum, and differential pressure switches shall be single or dual action with an adjustable setpoint for the process requirement and/or as specified herein. Switches shall be diaphragm or piston operated and activate S.P.D.T. snap action switches on increasing or decreasing pressure. Minimum differential shall be less than 10 percent of the range. Deadband shall be adjustable. Allowable surge pressure shall be a minimum 1.5 times the range. Each pressure switch shall have visible scale.
- B. Pressure switches shall have a contact rating of 10 amperes at 120 volts AC. Pressure switches shall be in NEMA 4X enclosures. Switches shall have a repeatable accuracy of 1 percent of range. Pressure switches shall be isolated from the process fluid by a diaphragm seal or an isolation ring in locations as shown on the Contract Drawings and/or as specified. Wetted parts materials shall be compatible with the process fluid for corrosion resistance. Pressure switches shall be manufactured by ASCO, SOR, Inc., Ashcroft, or equal.

PART 3 -- EXECUTION

3.1 REQUIREMENTS

- A. Refer to Section 17600 – Instruments – General.

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SECTION 17698

INSTRUMENTATION AND CONTROL SYSTEM ACCESSORIES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the instrumentation and control system accessories with all spare parts, and appurtenances as herein specified and as shown on the Drawings.
- B. Accessories include various items of equipment that may be required in the system but are not scheduled. Accessories are shown on details, flow sheets or plans. Accessories are also called out in specifications for scheduled instruments and in the installation specifications. It is not intended, however, that each piece of hardware required will be specifically described herein. This Specification shall be used as a guide to qualify requirements for miscellaneous hardware whether the specific item is described or not.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17600 – Instruments, General

1.3 SUBMITTALS

- A. Per Section 17030, Control and Information System Submittals
- B. Impulse piping layout and routing drawings
- C. Instrument assembly drawings.

PART 2 -- PRODUCTS

2.1 PROCESS TUBING

- A. Process, impulse, or capillary tubing shall be 1/2 x 0.065-inch seamless, annealed, ASTM A-269 Type 316L stainless steel with 37 degrees Type 316 stainless steel flared fittings or Swagelock or Parker-CPI flareless fittings.
- B. Piping for closely coupling instruments to process seals shall be standard stainless steel NPT threaded piping or NPT tapped mounting blocks.
- C. A nickel-based lubricant shall be used on threaded stainless steel piping connections to prevent galling.

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2.2 POWER, CONTROL, AND SIGNAL CABLES

- A. Power, control and signal wiring shall be provided under Division 16 of the Specifications, unless otherwise indicated.

2.3 DIAPHRAGM SEALS

- A. Diaphragm seals shall be provided for isolation of pressure gauges, switches and transmitters attached to systems containing chemical solutions or corrosive fluids. As a minimum, seals shall be of all 316 stainless steel construction. In general, diaphragms shall be 316L stainless steel for operating pressures at or above 15 psi and elastomers for operating pressures below 15 psi. However, all components shall be non-reactive with the process fluid in all cases. Refer to the Instrument Schedules for specific materials requirements.
- B. Seal shall have fill connection, 1/4-inch NPT valved flush port and capable of disassembly without loss of filler fluid. Where specified, diaphragm seals shall comply with the above requirements and shall be provided with 316 SS factory filled capillaries.
- C. Seals shall be Helicoid Type 100 HA, Mansfield & Green, Ashcroft, or equal.

2.4 ISOLATING RING SEALS

- A. For solids bearing fluids, line pressure shall be sensed by a flexible cylinder lining and transmitted via a captive sensing liquid to the associated pressure sensing instrument(s).
 - 1. Full Line Size Isolating Ring Seals
 - a. Where indicated, the sensor body shall be full line size wafer design.
 - b. Full line size isolating ring seals shall have 316 stainless steel housing and assembly flanges and Buna N flexible cylinder lining for in line mounting. The wafer shall have through bolt holes or centerline gauge for positive alignment with the associated flanged piping. Gauge or readout shall be oriented for viewing.
 - c. The captive liquid chamber and associated instrument(s) shall be furnished with threaded drain tap and plug. Manufacturer shall furnish seals with a quick-disconnect-type fitting for field disassembly and reassembly, however, seal and instruments shall be factory assembled prior to arriving at the job site
 - d. Isolating ring seals shall be RED Valve Series 40, Ronningen Petter Iso Ring, Moyno RKL Series W, Onyx Isolator Ring, or equal.
 - 2. Tapped Isolating Ring Seals
 - a. Where indicated, pressure shall be sensed via a minimum 1-1/2" diameter spool type isolating ring seal mounted on a 1-1/2" pipe nipple at 90 degrees from the process piping.
 - b. An isolation ball valve shall be provided between the process piping and the ring seal, and a cleanout ball valve shall be provided between the ring seal and the atmosphere. The factory assembled and filled pressure instrument shall be back or side mounted to the ring seal such that the gauge or readout may be viewed normally.
 - c. Tapped isolating ring seals for solids service shall be Red Valve Series 42/742, Ronningen Petter Iso Spool, Onyx Isolator Ring, or equal.

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2.5 FILLING MEDIUM:

- A. The filling medium between instruments, isolating ring seals and diaphragm seals shall be a liquid suitable for operation in an ambient temperature ranging from -10 degrees F to +150 degrees F.
- B. Filling medium shall be silicone unless oxidizing agents, such as sodium hypochlorite, are present, then halocarbon shall be used.

2.6 TAMPER EVIDENT PAINT

- A. Piping and screwed/bolted connections of instrumentation containing the filling medium shall be marked with a small continuous tick mark of tamper evident paint over each piping/instrument joint. Tamper evident paint shall be applied prior to instrument assemblies arriving on the job site. Disturbance of the joint shall break the paint.
- B. Instrument assemblies with broken paint or missing paint shall not be accepted and shall be repaired or replaced at no additional cost to Owner. Paint shall be Dykem Cross-Check or equal.

2.7 ISOLATION VALVES

- A. Isolation valves shall be 1/2 inch diameter ball valves, unless otherwise indicated, with a Type 316 stainless steel body, Type 316 stainless steel ball. Where 316 stainless steel is not compatible with the process fluid, materials of construction shall be suitable for the associated process fluid (e.g., PVC for chemical service).

2.8 ALARM ANNUNCIATION DEVICE

- A. Sirens:
 - 1. For Class I, Division 2 areas and non-hazardous areas:
 - a. Provide NEMA 4X and Class I, Division 2 rated alarm horn capable of 32 selectable warning tones. Coordinate tone selection with Owner. Volume shall be field adjustable between 0 and 114 dBA measured at 10 feet.
 - b. Alarm horn shall be the SelecTone 302GCX series with UTM tone module as manufactured by Federal Signal Corporation.
 - 2. For Class I, Division 1 areas:
 - a. Provide NEMA 4X and Class I, Division 1 rated alarm horn capable of 32 selectable warning tones. Coordinate tone selection with Owner. Volume shall be field adjustable between 0 and 114 dBA measured at 10 feet.
 - b. Alarm horn shall be the SelecTone 302X series with UTM tone module as manufactured by Federal Signal Corporation.
- B. Strobe Lights:
 - 1. Strobes located within the same room, or otherwise visible from any shared frame of view, shall be synchronized per the requirements of NFPA 72. Strobes shall be synchronized by the strobe manufacturer's synchronization module. Strobe circuits shall not exceed the continuous duty current rating of the synchronization module.

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- Synchronization module shall be Federal Signal Model SSM, Edwards Signaling Model EG1M-RM, or equal.
2. For Class I, Division 2 areas and non-hazardous areas:
 - a. Provide red strobe status indicator. Unit shall be rated NEMA 4X and Factory Mutual approved for a Class I, Division 2, Group D area. Unit shall contain a durable polycarbonate housing and be surface mount. Unit shall be UL listed. Strobe shall be powered from 24VDC.
 - b. Alarm strobe shall be Federal Signal Model 225XST, Edwards Signaling Model 116DEGEX-FJ, or equal.
 3. For Class I, Division 1 areas:
 - a. Provide red explosion proof dome covered strobe unit rated NEMA 4X and Factory Mutual certified for a Class I, Division 1, Group D area. Unit shall be UL listed. Strobe shall be powered from 24VDC.
 - b. Alarm strobe shall be Federal Signal Model 27XST, Edwards Signaling Model 116DEGEX-FJ, or equal. Compatible mounting hardware by the strobe manufacturer shall be furnished.
 4. Lens color shall be as indicated on the Drawings. [Available lens colors are amber, blue, clear, and red]

PART 3 -- EXECUTION

3.1 REQUIREMENTS

- A. Refer to Sections 17600, Part 3 of the Specifications.

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SECTION 17740

ULTRASONIC LIQUID LEVEL MEASUREMENT SYSTEMS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the ultrasonic liquid level measurement systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17600 – Instruments, General

1.3 TOOLS, SUPPLIES AND SPARE PARTS

- A. Furnish one hand-held programmer under this Contract to calibrate and configure the level controllers specified herein. The programmer shall be furnished complete with battery plus one spare battery, carrying case and accessories. Programmer shall be furnished by the level instrument manufacturer and shall be fully matched to the instrument furnished.
- B. Tools, supplies, and spare parts shall be per Section 17050 – Tools Supplies Spare Parts – General.

PART 2 -- PRODUCTS

2.1 ULTRASONIC LEVEL INSTRUMENTS

- A. Each ultrasonic level monitoring system shall include one ultrasonic level sensor and an "intelligent" transmitter (controller). The ultrasonic level monitoring system shall be required to monitor the level of process liquids or solids. Location of the sensor and transmitters shall be as shown on the Drawings and/or as specified
- B. The sensor shall be connected to a 316 stainless steel mounting flange or bracket by a 1-inch NPT orifice and flange mounted on stainless steel mounting brackets as shown. Mounting requirements shall be as shown on the Drawings.
- C. The level sensor shall be unaffected by moisture droplets on the transducer face and operate on the ultrasonic echo ranging principle. System accuracy shall be ± 1 mm plus 0.17% of measured distance. Resolution shall be 0.1% of range or 2mm.
- D. The transmitter shall display level with appropriate engineering units. The unit shall have a backlit LCD display which shall be shielded from direct sunlight.

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- E. The transmitter shall compensate for temperature and air density. Temperature compensation shall have a resolution of 0.1 degree C, with a linearity of 0.2 degree C. Output shall be linear, isolated 4 20 mA DC proportional to the measured level with embedded HART communication protocol. The units shall have a NEMA 4X polycarbonate enclosure and shall be suitable for operation in ambient temperatures of -20 to 50 Degree C.
- F. The transmitters shall have three programmable relay outputs (one SPDT and two SPST). Relay contacts shall be rated at 5A, 250 VAC.
- G. The transmitters shall have integrated data logging capability for viewing from the display such as daily data of maximum, minimum, and average level, temperature, level alarm information, echo profile and trends.
- H. The transmitters shall be powered by 120 VAC, 60 Hz, single phase power.
- I. Contractor shall coordinate length of transducer cable. Splices shall not be permitted, unless otherwise indicated.
- J. Ultrasonic level process measurement devices shall be the SITRANS LUT420 and Echomax Series Transducer as manufactured by Siemens, or equal by Vega.

PART 3 -- EXECUTION

3.1 REQUIREMENTS

- A. Where two or more ultrasonic level instruments are mounted in close proximity to each other, the transmitters shall coordinate operation to prevent interference from adjacent units. Coordination shall be accomplished via an interconnecting communication cable.
- B. Where level transducers may become submerged, provide a manufacturer-supplied submergence hood.
- C. Refer to Section 17600- Instruments, General for additional requirements.

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SECTION 17760

PRESSURE INDICATING TRANSMITTERS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the pressure transmitters, with all spare parts, accessories, and appurtenances as specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17600 – Instruments, General

PART 2 -- PRODUCTS

2.1 GAUGE PRESSURE INDICATING TRANSMITTERS

- A. Gauge pressure transmitters shall be of the capacitance type with a process isolated diaphragm with silicone oil fill, microprocessor based "smart" electronics, and a field adjustable rangeability of 100:1 input range. Span and zero shall be continuously adjustable externally over the entire range. Span and zero adjustments shall be capable of being disabled internally. Transmitters shall be NEMA 4X weatherproof and corrosion resistant construction with low copper aluminum body and 316 stainless steel process wetted parts. Accuracy, including nonlinearity, hysteresis and repeatability errors shall be plus or minus 0.025 percent of calibrated span, zero based. The maximum zero elevation and maximum zero suppression shall be adjustable to anywhere within sensor limits. Output shall be linear isolated 4 20 milliamperes 24 VDC. Power supply shall be 24 VDC, two-wire design. Each transmitter shall be furnished with a 4 digit LCD indicator capable of displaying engineering units and/or milliamps and mounting hardware as required. Overload capacity shall be rated at a minimum of 25 MPa. Environmental limits shall be 40 to 85 degrees Celsius at 0 100% relative humidity. Each transmitter shall have a stainless steel tag with calibration data attached to body.
- B. The piezoresistive silicon pressure sensor shall be mechanically, electrically, and thermally isolated from the process and the environment, shall include an integral temperature compensation sensor, and shall provide a digital signal to the transmitter's electronics for further processing. Factory set correction coefficients shall be stored in the sensor's non volatile memory for correction and linearization of the sensor output in the electronics section. The electronics section shall correct the digital signal from the sensor and convert it into a 4 20 mA analog signal for transmission to receiving devices. The electronics section shall contain configuration parameters and diagnostic data in non volatile EEPROM memory and shall be capable of communicating, via a digital signal superimposed on the 4 20 mA output

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signal, with a remote interface device. Output signal damping shall be provided, with an adjustable time constant of 0.36 seconds. Total long term stability (frequency of calibration) shall be not less than 0.20% URL for 15 years.

- C. Where scheduled, gauge pressure indicating transmitters shall be calibrated in feet of liquid for liquid level service.
- D. Gauge pressure indicating transmitters shall be Model 3051S1TG as manufactured by Emerson Process Management (Rosemount), or equal.

2.2 DIFFERENTIAL PRESSURE INDICATING TRANSMITTERS

- A. Differential pressure indicating transmitters shall be the same as the gauge pressure transmitters except for body specifications. Differential pressure units shall be furnished with close coupled stainless steel three valve manifold assembly.
- B. The electronics sections of differential pressure transmitters shall contain user selectable square root extractors to provide a linear 4-20 mA DC output proportional to flow, when activated. Square root extractor circuitry shall be activated only for incompressible fluid flow applications (i.e., water). Flow rates for compressible fluids (i.e., air) shall be calculated externally using line temperature and static pressure corrections as specified elsewhere in Division 17. In addition, each flow transmitter shall be furnished with laminated flow versus differential pressure curves wall mounted adjacent to the transmitter.
- C. Differential pressure indicating transmitters shall be Model 3051S1CD as manufactured by Emerson Process Management (Rosemount), or equal.

2.3 FLANGE MOUNTED LEVEL INDICATING TRANSMITTERS

- A. Flange-mounted tank liquid level indicating transmitters shall be the same as gauge pressure transmitters except for body type.
- B. The flange-mounted sensor shall consist of a special non-corrosive isolating diaphragm with fill fluid in a sealed capillary system to transmit liquid pressure to the sensing element. A second isolating diaphragm shall transmit pressure through the fill fluid to the sensing diaphragm in the center of the capacitance cell. An isolating diaphragm and fluid fill shall also be provided on the opposite side of the sensing diaphragm to convey atmospheric or reference pressure.
- C. All mounting flanges, diaphragms, O-rings and materials used in construction shall be non-corroding, compatible with each other, and compatible with the liquid being measured.
- D. Flange-mounted liquid level transmitters shall be Model 3051S Level Transmitter as manufactured by Emerson Process Management (Rosemount), or equal.

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PART 3 -- EXECUTION

3.1 REQUIREMENTS

- A. Refer to Section 17600 – Instruments, General.

- END OF SECTION -

SECTION 17784

ELECTRODE/CONDUCTANCE LEVEL SWITCHES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the conductance-actuated, probe-type liquid level switches, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17600 – Instruments, General

PART 2 -- PRODUCTS

2.1 ELECTRODE/CONDUCTANCE LEVEL SWITCH

- A. Electrodes shall be rigid AISI Type 316 stainless steel solid rods extended down into the process liquid. Electrode fittings shall be general-purpose, die-cast aluminum with epoxy-coated, pressure-tight assemblies sized to accommodate the electrode and shall be equipped with a 1-1/2" external pipe threads for attachment to the process trough.
- B. A separate conductance reference rod shall be provided.
- C. Electrode relays shall be solid-state type with double-pole, double-throw output contacts rated not less than 5 amperes at 120 volts ac. Relay primary power shall be 120 volts ac, 60 Hz, single phase. Intrinsically safe solid-state relays shall be utilized whenever the electrodes are located in a hazardous or explosion-proof classified area.
- D. Relays shall be housed in a NEMA Type 4 enclosure as indicated on the Drawings.
- E. Electrodes and conductance relays shall be as manufactured by B/W Controls, Inc., or equal.

PART 3 -- EXECUTION

3.1 REQUIREMENTS

- A. Refer to Section 17600 – instruments, General.

- END OF SECTION -

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SECTION 17852

GAS MONITORING SYSTEM

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the gas and safety monitoring system including, but not limited to, the single point gas monitoring instrumentation and a gas monitoring control panel, with all spare parts, accessories, and appurtenances as required for a fully functional system. Provide components as shown and as specified.
- B. Quantity and type of gas instrumentation shall be per Section 17910, Instrument Schedule and number of systems along with the number of annunciation devices shall be per the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 - Control and Information System Scope and General Requirements
- B. Section 17600 - Instruments, General
- C. Refer to Division 16 for additional requirements for cable, circuit breakers, disconnect switches, pilot lights, relays, etc.

1.3 TOOLS, SUPPLIES AND SPARE PARTS

- A. One spare sensor of each type used shall be furnished as spare. For sensors with a limited shelf life, manufacturer shall hold spare sensor and shall furnish at the sooner of when requested or 12-months after order.
- B. Calibration equipment and the actual calibration gas (zero and span), for each gas measured, shall be furnished to field calibrate the gas monitoring systems at start-up. Additionally, a one-year supply, assuming monthly calibration, of each gas that does not have a shelf life of less than one year shall be provided.
- C. Two spare relays for each type of relay used in the gas monitoring system.

1.4 QUALITY ASSURANCE

- A. Gas monitoring system design and panel construction shall be in compliance with Division 17 of these specifications, UL 508A. Panel drawings/design shall be signed and sealed by a registered Professional Engineer in the state where this project is being constructed. Control panel shall bear the UL mark.

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PART 2 -- PRODUCTS

2.1 GENERAL

- A. Gas monitoring instrumentation shall include a sensor to monitor the specified or shown gas, and a microprocessor-based transmitter that is capable of accepting, converting and transmitting signals from the sensor. The complete gas monitoring instrumentation including sensor, transmitter, and accessory equipment shall be supplied by a single manufacturer. One instrument shall be provided per gas per location.

2.2 GAS SENSORS

- A. All sensors shall sample and monitor the atmosphere without the aid of pumps or other mechanical devices, unless otherwise indicated. Sensors and associated enclosures shall be rated for installation in a Class I, Division 1 environment. Sensors shall be mounted with non-corrosive hardware.
- B. Provide sensors as shown on the drawings and according to the requirements herein.
 - 1. Combustible Gas (CG or CGD) Sensor: The combustible gas sensor shall be the infrared (IR) type and shall carry a 10-year warranty on sensor light source. It shall be immune to poisoning by hydrogen sulfide and silicone. The IR sensor shall allow detection of an above 100% LEL condition (over-range). The IR sensor shall not contain a flashback arrestor or frit.
 - 2. Hydrogen Sulfide (H2S) Sensor: The hydrogen sulfide sensor shall be the electrochemical type and shall not require the periodic addition of reagents. Sensor shall carry a two-year warranty.
 - 3. Oxygen (O2) Sensor: The oxygen sensor shall be the galvanic electrochemical type and shall not require the periodic addition of reagents. Sensor shall carry a two-year warranty
- C. Sensors shall be contained in modules mounted externally to the transmitter's enclosure. All sensor modules shall have the capability of replacement while the unit is under power in a hazardous area with declassifying the space and without the need for special tools.
- D. Sensor modules shall contain all relevant sensor information within the module so that the module may be calibrated off site. This information shall include sensor manufacturer date, gas type, gas range, calibration data, and default relay parameters. The sensor module shall not require a battery or power source to store this data.
- E. The sensor shall be capable of being mounted remotely from the transmitter as shown on drawings. The allowable distance from the remote mounted sensor to the transmitter shall be a minimum of 100 feet.

2.3 GAS TRANSMITTER

- A. The transmitter shall be rated for installation in a Class I, Division 1 environment. The transmitter shall have a digital readout to indicate, sequentially, the gas type being monitored and the concentration of gas present. The transmitter shall have normal, alarm, and fault indicating lights. Alarm level set points shall be adjustable by means of an intrinsically safe handheld controller/device.

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- B. Transmitter in conjunction with the appropriate sensor shall have the following specifications:
 - 1. Rated temperature range shall include, at a minimum -40°C to 60°C.
 - 2. Calibration drift shall be less than 5 percent per year, for zero setting and less than 10 percent per year for span setting.
 - 3. Accuracy, plus or minus, shall be as follows:
 - a. The lesser of two percent scale or two ppm for oxygen and monoxides of carbon.
 - b. Two percent full scale for less than 50 percent LEL and three percent full scale for greater than 50 percent LEL for combustibles.
 - c. The lesser of 10 percent full scale or 2 ppm for toxic gases.
 - d. The lesser of one percent full scale or two ppm for all others.
 - 4. Response times shall be as follows:
 - a. Less than 12 seconds for a 20 percent change in concentration and less than 30 percent for a 50 percent change in concentration for oxygen and toxic gas sensors.
 - b. Less than eight seconds for a 50 percent change in concentration and less than 20 seconds for a 90 percent change in concentration for combustible gas sensors.
 - 5. Humidity rating shall be 15 to 95 percent relative humidity, non-condensing.
 - 6. Sensor life shall be rated for three years for combustibles and two years for all others.
 - 7. Power and signal shall be 24 VDC via 3-wire 4-20 mA current source.
 - 8. Transmitter shall have three programmable normally closed or failsafe relay contacts rated at least 5A @ 24VDC.
- C. Calibration shall be performed by a handheld infrared controller. It shall not be necessary to open the monitor enclosure to perform calibration or adjustment of the unit. Except for a monthly check and recalibrations, no periodic maintenance shall be necessary. To facilitate one-person calibration of remote-mounted sensors, provide clear and flexible hose for the delivery of calibration gas to the sensor from near the transmitter. Provide all accessories necessary for installing hose.
- D. Gas monitoring instrumentation shall be MSA Model Ultima X-5000.

2.4 GAS MONITORING PANEL (GMCP-OC)

- A. Provide one wall-mount stainless steel NEMA 4X rated, gas monitoring panel. The gas monitoring panel shall be capable of monitoring all connected gas monitoring instrumentation and be able to relay that information to the PLC panel.
- B. Provide a fan driven panel-heater with thermostat for the purpose of elevating internal temperature sufficiently to avoid condensation.
- C. A UPS shall be provided for the gas monitoring control panel, the UPS shall be sized for at least 150% of connected load and shall provide backup power for at least 30 minutes with the panel power source disconnected. With the exception of the panel heater, all power, wiring, signals, relay logic, etc. shall be designed for 24VDC. Power supplies and UPS shall be manufactured by Puls, or equal

- D. The control panel shall be capable of receiving a single 120VAC power feed. A main circuit breaker shall be provided followed by a surge protection device and two 24VDC power supplies feeding a 24VDC UPS.
- E. All signals received at panel shall be relayed or retransmitted for output. Common input and output loops are not acceptable. Hardwired logic shall be designed fail-safe and shall use safety type control relays. No programmable controllers or similar devices shall be acceptable. Safety type control relays shall be manufactured by Allen-Bradley, Eaton, or equal. General purpose “ice-cube” style relays are permitted for general status indicating circuits where audible/visual annunciation is not required.
- F. Any internal panel component with a fault, okay, or status contact shall be monitored, provisions shall be made for re-transmitting to the PLC.
- G. Provide the following inputs:
1. Discrete remote silence dry contact from remote stations.
 2. Discrete remote test dry contact from remote stations.
 3. Discrete sensor failure, fault, or trouble input, per each gas transmitter.
 4. Discrete gas sensor alarm signal, per each gas transmitter.
 5. Analog 4-20 mA gas level signal input, per each gas transmitter.
- H. Provide the following outputs:
1. Discrete strobe output wetted contact to remote mount strobes.
 2. Discrete horn output wetted contact to remote mount horns.
 3. Discrete gas high level concentration, per each gas transmitter.
 4. Analog 4-20 mA gas level output signal, per each gas transmitter.
- I. Provide the following front panel mounted devices:
1. Control Power-On LED indicating lamp
 2. Gas Alarm push-to-test LED type indicating lamp
 3. Gas Fault push-to-test LED type indicating lamp
 4. Silence pushbutton
 5. Test pushbutton
 6. Gas level digital display readout, per gas sensor
 7. Audible horn
 8. Red Strobe beacon
 9. Nameplate to read, “ODOR CONTROL GAS MONITORING – GMCP-OC”
- J. Functional Description:
1. Gas instrumentation shall be powered from the gas monitoring control panel and the gas level for each sensor shall be displayed at the panel. Gas level shall also be re-transmitted to the PLC.
 2. Upon receipt of a gas alarm from any gas sensor connected to the system, the alarm contact shall close, the indicating lamp shall illuminate, the panel mounted horn and remote mounted horns shall sound and the panel mounted strobe beacon and remote mounted strobe beacons shall flash.
 3. Upon receipt of a gas failure, fault or trouble signal from any gas sensor connected to the system, the gas fault contact shall close, the indicating lamp shall illuminate, the panel mounted horn and remote mounted horns shall sound and the panel mounted strobe beacon and remote mounted strobe beacons shall flash.

4. When the alarm horns are sounding and the strobes are flashing, pressing any silence button or sending the signal remotely, shall silence the horn. The strobes shall continue to flash until the alarm or fault condition has cleared.

K. Panel shall be factory assembled and tested prior to shipment.

2.5 ANNUNCIATION DEVICES

A. Alarm Strobe

1. Strobes located within the same room, or otherwise visible from any shared frame of view, shall be synchronized per the requirements of NFPA 72. Strobes shall be synchronized by the strobe manufacturer's synchronization module. Strobe circuits shall not exceed the continuous duty current rating of the synchronization module. Synchronization module shall be Federal Signal Model SSM, Edwards Signaling Model EG1M-RM, or equal.
2. For Class I, Division 2 areas and non-hazardous areas
 - a. Provide red strobe status indicator. Unit shall be rated NEMA 4X and Factory Mutual approved for a Class I, Division 2, Group D area. Unit shall contain a durable polycarbonate housing and be surface mount. Unit shall be UL listed. Strobe shall be powered from 24VDC.
 - b. Alarm strobe shall be Federal Signal Model 225XST, Edwards Signaling Model 116DEGEX-FJ, or equal.
3. For Class I, Division 1 areas
 - a. Provide red explosion proof dome covered strobe unit rated NEMA 4X and Factory Mutual certified for a Class I, Division 1, Group D area. Unit shall be UL listed. Strobe shall be powered from 24VDC.
 - b. Alarm strobe shall be Federal Signal Model 27XST, Edwards Signaling Model 116DEGEX-FJ, or equal. Compatible mounting hardware by the strobe manufacturer shall be furnished.

B. Alarm Horn

1. For Class I, Division 2 areas and non-hazardous areas
 - a. Provide NEMA 4X and Class I, Division 2 rated alarm horn capable of 32 selectable warning tones. Coordinate tone selection with Owner. Volume shall be field adjustable between 0 and 114 dBA measured at 10 feet.
 - b. Alarm horn shall be the SelecTone 302X series with UTM tone module as manufactured by Federal Signal Corporation, or equal.
2. For Class I, Division 1 areas
 - a. Provide NEMA 4X and Class I, Division 1 rated alarm horn capable of 32 selectable warning tones. Coordinate tone selection with Owner. Volume shall be field adjustable between 0 and 114 dBA measured at 10 feet.
 - b. Alarm horn shall be the SelecTone 302X series with UTM tone module as manufactured by Federal Signal Corporation, or equal.

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PART 3 EXECUTION

3.1 REQUIREMENTS

- A. Gas instrumentation and monitoring panel shall be mounted as shown on the Drawings. Calibration gas delivery hose shall be installed neatly with zip-ties on the conduit between the transmitter and the sensor.
- B. For additional requirements, refer to Section 17600, Part 3 of the specifications.

-END OF SECTION-

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SECTION 17910
INSTRUMENT SCHEDULE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. Contractor shall furnish, test, install and place in satisfactory operation all instrumentation as herein specified, and Contractor shall furnish, test, install and place in satisfactory operation all instrumentation as shown on the Drawings.
- B. Although every effort has been made to ensure an accurate instrument schedule, errors may have been made.
- C. Only new instrumentation is scheduled, unless existing instrumentation needs modifications. All existing instrumentation shall be verified for accuracy and recalibrated. Contractor shall bring any existing instrumentations' deficiencies to the Engineer's attention.
- D. Instruments provided shall be rated for the proper area classification based on location. See Electrical drawings for instrument locations and area classification details.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17920 – Control System Input/Output Schedule
- B. Section 17950 – Functional Control Descriptions

PART 2 -- INSTRUMENT SCHEDULE

Rotameters – Section 17635			
FICV-SG851	Grit Pump No. 1 Seal Water Flow		Provided by equipment manufacturer
FICV-SG852	Grit Pump No. 2 Seal Water Flow		Provided by equipment manufacturer
FICV-SG853	Grit Pump No. 3 Seal Water Flow		Provided by equipment manufacturer
FICV-SG854	Grit Pump No. 4 Seal Water Flow		Provided by equipment manufacturer
Pressure Gauges – Section 17650			
Tag No.	Service Description	Span	Remarks
PI-SG851A	Grit Pump No. 1 Suction Pressure	0 – 60 psig	With in-line annular seal. Located in Class I, Div. 1 area.
PI-SG851B	Grit Pump No. 1 Discharge Pressure	0 – 100 psig	With in-line annular seal. Common assembly with PSH-SG851.

			Located in Class I, Div. 1 area.
PI-SG852A	Grit Pump No. 2 Suction Pressure	0 – 60 psig	With in-line annular seal. Located in Class I, Div. 1 area.
PI-SG852B	Grit Pump No. 2 Discharge Pressure	0 – 100 psig	With in-line annular seal. Common assembly with PSH-SG852. Located in Class I, Div. 1 area.
PI-SG853A	Grit Pump No. 3 Suction Pressure	0 – 60 psig	With in-line annular seal. Located in Class I, Div. 1 area.
PI-SG853B	Grit Pump No. 3 Discharge Pressure	0 – 100 psig	With in-line annular seal. Common assembly with PSH-SG853. Located in Class I, Div. 1 area.
PI-SG854A	Grit Pump No. 4 Suction Pressure	0 – 60 psig	With in-line annular seal. Located in Class I, Div. 1 area.
PI-SG854B	Grit Pump No. 4 Discharge Pressure	0 – 100 psig	With in-line annular seal. Common assembly with PSH-SG853. Located in Class I, Div. 1 area.
PI-SG913	Odor Control Fan No. 1 Suction Pressure	0 – 60 psig	With diaphragm seal. Common assembly with PSL-SG913. Located in Class I, Div. 2 area. Provided by Manufacturer.
PI-SG917	Odor Control Fan No. 1 Discharge Pressure	0 – 100 psig	With diaphragm seal. Common assembly with PSH-SG917. Located in Class I, Div. 2 area. Provided by Manufacturer.
PI-SG923	Odor Control Fan No. 2 Suction Pressure	0 – 60 psig	With diaphragm seal. Common assembly with PSL-SG923. Located in Class I, Div. 2 area. Provided by Manufacturer.
PI-SG927	Odor Control Fan No. 2 Discharge Pressure	0 – 100 psig	With diaphragm seal. Common assembly with PSH-SG927. Located in Class I, Div. 2 area. Provided by Manufacturer.

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PI-SG950	South Grit Sump Pump Discharge Pressure High	0 – 60 psig	With diaphragm seal. Located in Class I, Div. 2 area.
PI-SG960	North Grit Auger Dry Well Sump Pump Discharge Pressure High	0 – 60 psig	With diaphragm seal. Located in Class I, Div. 2 area.
PI-SG970	North Dumpster Room Sump Pump Discharge Pressure High	0 – 60 psig	With diaphragm seal. Located in Class I, Div. 2 area.
PI-SG980	Lower Alcove Area Sump Pump Discharge Pressure High	0 – 60 psig	With diaphragm seal. Located in Class I, Div. 2 area.
PI-SG990	South Garage Sump Pump Discharge Pressure High	0 – 60 psig	With diaphragm seal. Located in Class I, Div. 2 area.
Level Switches (Suspended Float) – Section 17670			
Tag No.	Service Description	Span	Remarks
LSH-SG959	Odor Control Room Flood Level	Set @ 6" AFF	Located in Class I Div. 1 area
LSHH-SG950	South Grit Drywell Sump Pump Float Switch High Level	Set @ EL. 732.0	Located in Class I Div. 1 area Provided by Manufacturer
LSH-SG950	South Grit Drywell Sump Pump Float Switch Lag Level	Set @ EL. 731.8	Located in Class I Div. 1 area Provided by Manufacturer
LSL-SG950	South Grit Drywell Sump Pump Float Switch Lead Level	Set @ EL. 731.6	Located in Class I Div. 1 area Provided by Manufacturer
LSSL-SG950	South Grit Drywell Sump Pump All Pumps Off	Set @ EL. 730.9	Located in Class I Div. 1 area Provided by Manufacturer
LSHH-SG960	North Grit Auger Drywell Sump Pump Float Switch High Level	Set @ EL. 731.50	Located in Class I Div. 1 area Provided by Manufacturer
LSH-SG960	North Grit Auger Drywell Sump Pump Float Switch Lag Level	Set @ EL. 730.8	Located in Class I Div. 1 area Provided by Manufacturer
LSL-SG960	North Grit Auger Drywell Sump Pump Float Switch Lead Level	Set @ EL. 730.1	Located in Class I Div. 1 area Provided by Manufacturer
LSSL-SG960	North Grit Auger Drywell Sump Pump All Pumps Off	Set @ EL. 729.4	Located in Class I Div. 1 area Provided by Manufacturer

LSHH-SG970	North Dumpster Room Sump Pump Float Switch High Level	Set @ EL. 598.8	Located in Class I Div. 1 area Provided by Manufacturer
LSH-SG970	North Dumpster Room Sump Pump Float Switch Lag Level	Set @ EL. 598.8	Located in Class I Div. 1 area Provided by Manufacturer
LSL-SG970	North Dumpster Room Sump Pump Float Switch Lead Level	Set @ EL. 598.1.4	Located in Class I Div. 1 area Provided by Manufacturer
LSLL-SG970	North Dumpster Room Sump Pump All Pumps Off	Set @ EL. 598.1	Located in Class I Div. 1 area Provided by Manufacturer
LSHH-SG980	Lower Alcove Area Sump Pump Float Switch High Level	Set @ EL. 599.25	Located in Class I Div. 1 area Provided by Manufacturer
LSH-SG980	Lower Alcove Area Sump Pump Float Switch Lag Level	Set @ EL. 598.8	Located in Class I Div. 1 area Provided by Manufacturer
LSL-SG980	Lower Alcove Area Sump Pump Float Switch Lead Level	Set @ EL. 598.1	Located in Class I Div. 1 area Provided by Manufacturer
LSLL-SG980	Lower Alcove Area Sump Pump All Pumps Off	Set @ EL. 598.1	Located in Class I Div. 1 area Provided by Manufacturer
LSHH-SG990	South Garage Sump Pump Float Switch High Level	TBD	Located in Class I Div. 1 area Provided by Manufacturer
LSH-SG990	South Garage Sump Pump Float Switch Lag Level	TBD	Located in Class I Div. 1 area Provided by Manufacturer
LSL-SG990	South Garage Sump Pump Float Switch Lead Level	TBD	Located in Class I Div. 1 area Provided by Manufacture
LSLL-SG990	South Garage Sump Pump All Pumps Off	TBD	Located in Class I Div. 1 area Provided by Manufacturer
Pressure Switches – Section 17675			
Tag No.	Service Description	Span	Remarks
PSH-SG851	Grit Pump No. 1 Discharge High Pressure	0 – 100 PSI Set @ TBD	See PI-SG851B

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PSH-SG852	Grit Pump No. 2 Discharge High Pressure	0 – 100 PSI Set @ TBD	See PI-SG852B
PSH-SG853	Grit Pump No. 3 Discharge High Pressure	0 – 100 PSI Set @ TBD	See PI-SG853B
PSH-SG854	Grit Pump No. 4 Discharge High Pressure	0 – 100 PSI Set @ TBD	See PI-SG854B
PSL-SG913	Odor Control Fan No. 1 Suction Low Pressure	0 – 100 PSI Set @ TBD	See PI-SG913
PSL-SG923	Odor Control Fan No. 2 Suction Low Pressure	0 – 100 PSI Set @ TBD	See PI-SG913
PSH-SG917	Odor Control Fan No. 1 Discharge High Pressure	0 – 100 PSI Set @ TBD	See PI-SG913
PSH-SG927	Odor Control Fan No. 2 Discharge High Pressure	0 – 100 PSI Set @ TBD	See PI-SG913
Ultrasonic Level Measurement Systems – Section 17740			
Tag No.	Service Description	Span	Remarks
LE/LIT-SG701	Screens Influent Chamber Level		Transducer Located in Class I Div. 1 area. Integral Mounted Transmitter.
LIT-SG721 LE-SG721A LE-SG721B	Screen No. 1 Differential Level Upstream Down Stream		Dual Sensor Ultrasonic Level Transmitter. Transducer located in Class I, Div. 1 area: Remote mounted transmitter. Provided by Screen Manufacturer.
LIT-SG722 LE-SG722A LE-SG722B	Screen No. 2 Differential Level Upstream Down Stream		Dual Sensor Ultrasonic Level Transmitter. Transducer located in Class I, Div. 1 area: Remote mounted transmitter. Provided by Screen Manufacturer. Provided by Screen Manufacturer.
LIT-SG723 LE-SG723A LE-SG723B	Screen No. 3 Differential Level Upstream Down Stream		Dual Sensor Ultrasonic Level Transmitter. Transducer located in Class I, Div. 1 area: Remote mounted transmitter. Provided by Screen Manufacturer.
Pressure and Differential Pressure Transmitters – Section 17760			
Tag No.	Service Description	Span	Remarks
LIT-SG871	Grit Washer No. 1 Pressure (Level Sensing)	TBD	Provided By Manufacturer
LIT-SG881	Grit Washer No. 2 Pressure (Level Sensing)	TBD	Provided By Manufacturer

PDIT-SG911	Grease Filter No. 1 Differential Pressure	0 – 100 PSI Set @ TBD	Provided By Manufacturer
PDIT-SG921	Grease Filter No. 2 Differential Pressure	0 – 100 PSI Set @ TBD	Provided By Manufacturer
PDIT-SG919A	Carbon Vessel No. 1 Bottom Media Differential Pressure	0 – 100 PSI Set @ TBD	Provided By Manufacturer
PDIT-SG919B	Carbon Vessel No. 1 Top Media Differential Pressure	0 – 100 PSI Set @ TBD	Provided By Manufacturer
PDIT-SG929A	Carbon Vessel No. 2 Bottom Media Differential Pressure	0 – 100 PSI Set @ TBD	Provided By Manufacturer
PDIT-SG929B	Carbon Vessel No. 2 Top Media Differential Pressure	0 – 100 PSI Set @ TBD	Provided By Manufacturer
Gas Monitoring System – Section 17852			
Tag No.	Service Description	Span	Remarks
AE/AIT-SG991	Odor Control Room Toxic Gas Detector (H2S)	0-100 ppm	
AE/AIT-SG992	Odor Control Room Oxygen Detector	0-100%	
AE/AIT-SG993	Odor Control Room Combustible Gas Detector	0-100 LEL	

-END OF SECTION-

SECTION 17920

CONTROL SYSTEM INPUT / OUTPUT SCHEDULE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install, and place in satisfactory operation all instrumentation as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17910 - Instrument Schedule
- B. Section 17950 - Functional Control Descriptions

PART 2 -- CONTROL SYSTEM INPUT / OUTPUT SCHEDULE

DWG	SERVICE DESCRIPTION	STATE/SPAN	TYPE	PLC	TAG
SCREENS INFLUENT CHAMBER					
I03A	INFLUENT CHAMBER LEVEL	ALARM	AI	PLC-SG	LIT-SG701
SCREEN No. 1 / WASHER COMPACTOR No. 1 (North)					
I03A	SCREEN No. 1 (SCN-SG721) SWITCH STATUS	IN AUTO	NDI	PLC-SG	HSI-SG721
I03A	SCREEN No. 1 (SCN-SG721) SPEED	0-100 %	NAI	PLC-SG	SI-SG721
I03A	SCREEN No. 1 (SCN-SG721) STATUS	RUNNING	NDI	PLC-SG	YN-SG721
I03A	SCREEN No. 1 (SCN-SG721) ALARM	DRIVE OVERLOAD	NDI	PLC-SG	YA-SG721A
I03A	SCREEN No. 1 (SCN-SG721) ALARM	FAIL	NDI	PLC-SG	YA-SG721B
I03A	SCREEN No. 1 (SCN-SG721) ALARM	FAIL TO START	NDI	PLC-SG	YA-SG721C
I03A	SCREEN No. 1 (SCN-SG721) ALARM	PANEL HIGH TEMP	NDI	PLC-SG	TAH-SG721
I03A	SCREEN No. 1 (SCN-SG721) UPSTREAM CHANNEL LEVEL	0-7 FT	NAI	PLC-SG	LIR-SG721A
I03A	SCREEN No. 1 (SCN-SG721) DOWNSTREAM CHANNEL LEVEL	0-7 FT	NAI	PLC-SG	LIR-SG721B

DWG	SERVICE DESCRIPTION	STATE/SPAN	TYPE	PLC	TAG
I03A	SCREEN No. 1 (SCN-SG721) COMMAND	ENABLE	NDO	PLC-SG	HS-SG721A
I03A	SCREEN No. 1 (SCN-SG721) CONTROL MODE	SELECTOR	NDO	PLC-SG	HS-SG721B
I03A	SCREEN No. 1 (SCN-SG721) SETPOINT CONTROL	TIMER	NDO	PLC-SG	KC-SG721
I03A	SCREEN No. 1 (SCN-SG721) ALARM	E-STOP ACTIVATED	NDI	PLC-SG	YA-SG721D
I03A	SCREEN No. 1 (SCN-SG721) RESET CONTROL	E-STOP RESET	NDO	PLC-SG	HS-SG721C
I03A	COMPACTOR No. 1 (CMP-SG761) COMMAND	START/STOP	NDO	PLC-SG	HS-SG761A
I03A	COMPACTOR No. 1 (CMP-SG761) COMMAND	RUN FORWARD	NDI	PLC-SG	YN-SG761B
I03A	COMPACTOR No. 1 (CMP-SG761) COMMAND	RUN REVERSE	NDI	PLC-SG	YN-SG761C
I03A	COMPACTOR No. 1 (CMP-SG761) ALARM	E-STOP ACTIVATED	NDI	PLC-SG	YN-SG761
I03A	COMPACTOR No. 1 (CMP-SG761) RESET CONTROL	E-STOP RESET	NDO	PLC-SG	HS-SG761B
SCREEN No. 2 / WASHER COMPACTOR No. 2 (North)					
I03A	SCREEN No. 2 (SCN-SG722) SWITCH STATUS	IN AUTO	NDI	PLC-SG	HSI-SG722
I03A	SCREEN No. 2 (SCN-SG722) SPEED	0-100 %	NAI	PLC-SG	SI-SG722
I03A	SCREEN No. 2 (SCN-SG722) STATUS	RUNNING	NDI	PLC-SG	YN-SG722
I03A	SCREEN No. 2 (SCN-SG722) ALARM	DRIVE OVERLOAD	NDI	PLC-SG	YA-SG722A
I03A	SCREEN No. 2 (SCN-SG722) ALARM	FAIL	NDI	PLC-SG	YA-SG722B
I03A	SCREEN No. 2 (SCN-SG722) ALARM	FAIL TO START	NDI	PLC-SG	YA-SG722C
I03A	SCREEN No. 2 (SCN-SG722) ALARM	PANEL HIGH TEMP	NDI	PLC-SG	TAH-SG722
I03A	SCREEN No. 2 (SCN-SG722) UPSTREAM CHANNEL LEVEL	0-7 FT	NAI	PLC-SG	LIR-SG722A
I03A	SCREEN No. 2 (SCN-SG722) DOWNSTREAM CHANNEL LEVEL	0-7 FT	NAI	PLC-SG	LIR-SG722B
I03A	SCREEN No. 2 (SCN-SG722) COMMAND	ENABLE	NDO	PLC-SG	HS-SG722A
I03A	SCREEN No. 2 (SCN-SG722) CONTROL MODE	SELECTOR	NDO	PLC-SG	HS-SG722B
I03A	SCREEN No. 2 (SCN-SG722) SETPOINT CONTROL	TIMER	NDO	PLC-SG	KC-SG722

DWG	SERVICE DESCRIPTION	STATE/SPAN	TYPE	PLC	TAG
I03A	SCREEN No. 2 (SCN-SG722) ALARM	E-STOP ACTIVATED	NDI	PLC-SG	YA-SG722D
I03A	SCREEN No. 2 (SCN-SG722) RESET CONTROL	E-STOP RESET	NDO	PLC-SG	HS-SG722C
I03A	COMPACTOR No. 2 (CMP-SG762) COMMAND	START/STOP	NDO	PLC-SG	HS-SG762A
I03A	COMPACTOR No. 2 (CMP-SG762) COMMAND	RUN FORWARD	NDI	PLC-SG	YN-SG762B
I03A	COMPACTOR No. 2 (CMP-SG762) COMMAND	RUN REVERSE	NDI	PLC-SG	YN-SG762C
I03A	COMPACTOR No. 2 (CMP-SG762) ALARM	E-STOP ACTIVATED	NDI	PLC-SG	YN-SG762
I03A	COMPACTOR No. 2 (CMP-SG762) RESET CONTROL	E-STOP RESET	NDO	PLC-SG	HS-SG762B
SCREEN No. 3 / WASHER COMPACTOR No. 3 (South)					
I03A	SCREEN No. 3 (SCN-SG723) SWITCH STATUS	IN AUTO	NDI	PLC-SG	HSI-SG723
I03A	SCREEN No. 3 (SCN-SG723) SPEED	0-100 %	NAI	PLC-SG	SI-SG723
I03A	SCREEN No. 3 (SCN-SG723) STATUS	RUNNING	NDI	PLC-SG	YN-SG723
I03A	SCREEN No. 3 (SCN-SG723) ALARM	DRIVE OVERLOAD	NDI	PLC-SG	YA-SG723A
I03A	SCREEN No. 3 (SCN-SG723) ALARM	FAIL	NDI	PLC-SG	YA-SG723B
I03A	SCREEN No. 3 (SCN-SG723) ALARM	FAIL TO START	NDI	PLC-SG	YA-SG723C
I03A	SCREEN No. 3 (SCN-SG723) ALARM	PANEL HIGH TEMP	NDI	PLC-SG	TAH-SG732
I03A	SCREEN No. 3 (SCN-SG723) UPSTREAM CHANNEL LEVEL	0-7 FT	NAI	PLC-SG	LIR-SG723A
I03A	SCREEN No. 3 (SCN-SG723) DOWNSTREAM CHANNEL LEVEL	0-7 FT	NAI	PLC-SG	LIR-SG723B
I03A	SCREEN No. 3 (SCN-SG723) COMMAND	ENABLE	NDO	PLC-SG	HS-SG723
I03A	SCREEN No. 3 (SCN-SG723) CONTROL MODE	SELECTOR	NDO	PLC-SG	HS-SG723B
I03A	SCREEN No. 3 (SCN-SG723) SETPOINT CONTROL	TIMER	NDO	PLC-SG	KC-SG723
I03A	SCREEN No. 3 (SCN-SG723) ALARM	E-STOP ACTIVATED	NDI	PLC-SG	YA-SG723D
I03A	SCREEN No. 3 (SCN-SG723) RESET CONTROL	E-STOP RESET	NDO	PLC-SG	HS-SG723C
I03A	COMPACTOR No. 3 (CMP-SG765) COMMAND	START/STOP	NDO	PLC-SG	HS-SG765A

DWG	SERVICE DESCRIPTION	STATE/SPAN	TYPE	PLC	TAG
I03A	COMPACTOR No. 3 (CMP-SG765) COMMAND	RUN FORWARD	NDI	PLC-SG	YN-SG765B
I03A	COMPACTOR No. 3 (CMP-SG765) COMMAND	RUN REVERSE	NDI	PLC-SG	YN-SG765C
I03A	COMPACTOR No. 3 (CMP-SG765) ALARM	E-STOP ACTIVATED	NDI	PLC-SG	YN-SG765
I03A	COMPACTOR No. 3 (CMP-SG765) RESET CONTROL	E-STOP RESET	NDO	PLC-SG	HS-SG765B
GRIT COLLECTOR No. 1 (North)					
I05	GRIT COLLECTOR No. 1 (GC-SG812) ALARM	ZERO SPEED	NDI	PLC-SG	YA-SG812A
I05	GRIT COLLECTOR No. 1 (GC-SG812) SWITCH STATUS	IN AUTO	NDI	PLC-SG	HSI-SG812
I05	GRIT COLLECTOR No. 1 (GC-SG812) COMMAND	START/STOP	NDO	PLC-SG	HS-SG812A
I05	GRIT COLLECTOR No. 1 (GC-SG812) STATUS	RUNNING	NDI	PLC-SG	YN-SG812
I05	GRIT COLLECTOR No. 1 (GC-SG812) ALARM	FAULT	NDI	PLC-SG	YA-SG812B
I05	GRIT COLLECTOR No. 1 (GC-SG812) ALARM	OVERLOAD	NDI	PLC-SG	YA-SG812C
I05	GRIT COLLECTOR No. 1 (GC-SG812) ALARM	MOTOR HIGH TEMP	NDI	PLC-SG	YA-SG812D
I03A	GRIT COLLECTOR No. 1 (GC-SG812) ALARM	E-STOP ACTIVATED	NDI	PLC-SG	YA-SG812E
I03A	GRIT COLLECTOR No. 1 (GC-SG812) RESET CONTROL	E-STOP RESET	NDO	PLC-SG	HS-SG812B
GRIT PUMP No. 1 (North)					
I05	GRIT PUMP No. 1 (P-SG851) SWITCH STATUS	IN REMOTE	NDI	PLC-SG	HSI-SG851
I05	GRIT PUMP No. 1 (P-SG851) COMMAND	START/STOP	NDO	PLC-SG	HS-SG851A
I05	GRIT PUMP No. 1 (P-SG851) STATUS	RUNNING	NDI	PLC-SG	YN-SG851
I05	GRIT PUMP No. 1 (P-SG851) ALARM	OVERLOAD	NDI	PLC-SG	YA-SG851A
I05	GRIT PUMP No. 1 (P-SG851) ALARM	FAULT	NDI	PLC-SG	YA-SG851B
I05	GRIT PUMP No. 1 (P-SG851) ALARM	MOTOR HIGH TEMP	NDI	PLC-SG	YA-SG851C
I05	GRIT PUMP No. 1 (P-SG851) ALARM	E-STOP ACTIVATED	NDI	PLC-SG	YA-SG851D
I05	GRIT PUMP No. 1 (P-SG851) ALARM	E-STOP RESET	NDO	PLC-SG	HS-SG851B

DWG	SERVICE DESCRIPTION	STATE/SPAN	TYPE	PLC	TAG
GRIT PUMP No. 2 (North)					
I05	GRIT PUMP No. 2 (P-SG852) SWITCH STATUS	IN REMOTE	NDI	PLC-SG	HSI-SG852
I05	GRIT PUMP No. 2 (P-SG852) COMMAND	START/STOP	NDO	PLC-SG	HS-SG852A
I05	GRIT PUMP No. 2 (P-SG852) STATUS	RUNNING	NDI	PLC-SG	YN-SG852
I05	GRIT PUMP No. 2 (P-SG852) ALARM	OVERLOAD	NDI	PLC-SG	YA-SG852A
I05	GRIT PUMP No. 2 (P-SG852) ALARM	FAULT	NDI	PLC-SG	YA-SG852B
I05	GRIT PUMP No. 2 (P-SG852) ALARM	MOTOR HIGH TEMP	NDI	PLC-SG	YA-SG852C
I05	GRIT PUMP No. 2 (P-SG852) ALARM	E-STOP ACTIVATED	NDI	PLC-SG	YA-SG852D
I05	GRIT PUMP No. 2 (P-SG852) ALARM	E-STOP RESET	NDO	PLC-SG	HS-SG852B
GRIT COLLECTOR No. 2 (South)					
I06	GRIT COLLECTOR No. 2 (GC-SG822) ALARM	ZERO SPEED	NDI	PLC-SG	YA-SG822A
I06	GRIT COLLECTOR No. 2 (GC-SG822) SWITCH STATUS	IN AUTO	NDI	PLC-SG	HSI-SG822
I06	GRIT COLLECTOR No. 2 (GC-SG822) COMMAND	START/STOP	NDO	PLC-SG	HS-SG822A
I06	GRIT COLLECTOR No. 2 (GC-SG822) STATUS	RUNNING	NDI	PLC-SG	YN-SG822
I06	GRIT COLLECTOR No. 2 (GC-SG822) ALARM	FAULT	NDI	PLC-SG	YA-SG822B
I06	GRIT COLLECTOR No. 2 (GC-SG822) ALARM	OVERLOAD	NDI	PLC-SG	YA-SG822C
I06	GRIT COLLECTOR No. 2 (GC-SG822) ALARM	MOTOR HIGH TEMP	NDI	PLC-SG	YA-SG822D
I06	GRIT COLLECTOR No. 2 (GC-SG822) ALARM	E-STOP ACTIVATED	NDI	PLC-SG	YA-SG822E
I06	GRIT COLLECTOR No. 2 (GC-SG822) RESET CONTROL	E-STOP RESET	NDO	PLC-SG	HS-SG822B
GRIT PUMP No. 3 (South)					
I06	GRIT PUMP No. 3 (P-SG853) SWITCH STATUS	IN REMOTE	NDI	PLC-SG	HSI-SG853
I06	GRIT PUMP No. 3 (P-SG853) COMMAND	START/STOP	NDO	PLC-SG	HS-SG853
I06	GRIT PUMP No. 3 (P-SG853) STATUS	RUNNING	NDI	PLC-SG	YN-SG853A

DWG	SERVICE DESCRIPTION	STATE/SPAN	TYPE	PLC	TAG
I06	GRIT PUMP No. 3 (P-SG853) ALARM	OVERLOAD	NDI	PLC-SG	YA-SG853A
I06	GRIT PUMP No. 3 (P-SG853) ALARM	FAULT	NDI	PLC-SG	YA-SG853B
I06	GRIT PUMP No. 3 (P-SG853) ALARM	MOTOR HIGH TEMP	NDI	PLC-SG	YA-SG853C
I06	GRIT PUMP No. 3 (P-SG853) ALARM	E-STOP ACTIVATED	NDI	PLC-SG	YA-SG853D
I06	GRIT PUMP No. 3 (P-SG853) ALARM	E-STOP RESET	NDO	PLC-SG	HS-SG853B
GRIT PUMP No. 4 (South)					
I06	GRIT PUMP No. 4 (P-SG854) SWITCH STATUS	IN REMOTE	NDI	PLC-SG	HSI-SG854
I06	GRIT PUMP No. 4 (P-SG854) COMMAND	START/STOP	NDO	PLC-SG	HS-SG854A
I06	GRIT PUMP No. 4 (P-SG854) STATUS	RUNNING	NDI	PLC-SG	YN-SG854
I06	GRIT PUMP No. 4 (P-SG854) ALARM	OVERLOAD	NDI	PLC-SG	YA-SG854A
I06	GRIT PUMP No. 4 (P-SG854) ALARM	FAULT	NDI	PLC-SG	YA-SG854B
I06	GRIT PUMP No. 4 (P-SG854) ALARM	MOTOR HIGH TEMP	NDI	PLC-SG	YA-SG854C
I06	GRIT PUMP No. 4 (P-SG854) ALARM	E-STOP ACTIVATED	NDI	PLC-SG	YA-SG854D
I06	GRIT PUMP No. 4 (P-SG854) ALARM	E-STOP RESET	NDO	PLC-SG	HS-SG854B
GRIT WASHER No. 1 (North)					
I07	GRIT WASHER No. 1 DRAIN VALVE No. 1 (MOV-SG875) SWITCH STATUS	IN AUTO	NDI	PLC-SG	HSI-SG875
I07	GRIT WASHER No. 1 DRAIN VALVE No. 1 (MOV-SG875) POSITION	FULLY OPENED	NDI	PLC-SG	ZIC-SG875B
I07	GRIT WASHER No. 1 DRAIN VALVE No. 1 (MOV-SG875) POSITION	FULLY CLOSED	NDI	PLC-SG	ZIO-SG875B
I07	GRIT WASHER No. 1 DRAIN VALVE No. 1 (MOV-SG875) COMMAND	OPEN	NDO	PLC-SG	HS-SG875C
I07	GRIT WASHER No. 1 DRAIN VALVE No. 1 (MOV-SG876) COMMAND	CLOSE	NDO	PLC-SG	HS-SG875D

DWG	SERVICE DESCRIPTION	STATE/SPAN	TYPE	PLC	TAG
I07	GRIT WASHER No. 1 DRAIN VALVE No. 2 (MOV-SG876) SWITCH STATUS	IN AUTO	NDI	PLC-SG	HSI-SG876
I07	GRIT WASHER No. 1 DRAIN VALVE No. 2 (MOV-SG876) POSITION	FULLY OPENED	NDI	PLC-SG	ZIC-SG876B
I07	GRIT WASHER No. 1 DRAIN VALVE No. 2 (MOV-SG876) POSITION	FULLY CLOSED	NDI	PLC-SG	ZIO-SG876B
I07	GRIT WASHER No. 1 DRAIN VALVE No. 2 (MOV-SG876) COMMAND	OPEN	NDO	PLC-SG	HS-SG876C
I07	GRIT WASHER No. 1 DRAIN VALVE No. 2 (MOV-SG876) COMMAND	CLOSE	NDO	PLC-SG	HS-SG876D
I07	GRIT WASHER No. 1 STIRRER No. 1 (GM-SG871) SWITCH STATUS	IN AUTO	NDI	PLC-SG	HSI-SG871
I07	GRIT WASHER No. 1 STIRRER No. 1 (GM-SG871) COMMAND	START/STOP	NDO	PLC-SG	HS-SG871
I07	GRIT WASHER No. 1 STIRRER No. 1 (GM-SG871) STATUS	RUNNING	NDI	PLC-SG	YN-SG871
I07	GRIT WASHER No. 1 STIRRER No. 1 (GM-SG871) ALARM	FAIL	NDI	PLC-SG	YA-SG871A
I07	GRIT WASHER No. 1 STIRRER No. 1 (GM-SG871) ALARM	FAIL TO START	NDI	PLC-SG	YA-SG871B
I07	GRIT WASHER No. 1 STIRRER No. 1 (GM-SG871) ALARM	E-STOP ACTIVATED	NDI	PLC-SG	YA-SG871C
I07	GRIT WASHER No. 1 (GM-SG871) LEVEL	LEVEL	NAI	PLC-SG	LIR-SG871
I07	GRIT WASHER No. 1 SCREW No. 1 (GM-SG873) SWITCH STATUS	IN AUTO	NDI	PLC-SG	HSI-SG873
I07	GRIT WASHER No. 1 SCREW No. 1 (GM-SG873) COMMAND	START/STOP	NDO	PLC-SG	HS-SG873
I07	GRIT WASHER No. 1 SCREW No. 1 (GM-SG873) STATUS	RUNNING	NDI	PLC-SG	YN-SG873

DWG	SERVICE DESCRIPTION	STATE/SPAN	TYPE	PLC	TAG
I07	GRIT WASHER No. 1 SCREW No. 1 (GM-SG873) ALARM	FAIL	NDI	PLC-SG	YA-SG873A
I07	GRIT WASHER No. 1 SCREW No. 1 (GM-SG873) ALARM	FAIL TO START	NDI	PLC-SG	YA-SG873B
I07	GRIT WASHER No. 1 SCREW No. 1 (GM-SG873) ALARM	E-STOP ACTIVATED	NDI	PLC-SG	YA-SG873C
GRIT WASHER No. 2					
I08	GRIT WASHER No. 2 DRAIN VALVE No. 1 (MOV-SG885) SWITCH STATUS	IN AUTO	NDI	PLC-SG	HSI-SG885
I07B	GRIT WASHER No. 2 DRAIN VALVE No. 1 (MOV-SG885) POSITION	FULLY CLOSED	NDI	PLC-SG	ZIO-SG885B
I08	GRIT WASHER No. 2 DRAIN VALVE No. 1 (MOV-SG885) POSITION	FULLY OPENED	NDI	PLC-SG	ZIC-SG885B
I08	GRIT WASHER No. 2 DRAIN VALVE No. 1 (MOV-SG885) COMMAND	OPEN	NDO	PLC-SG	HS-SG885C
I08	GRIT WASHER No. 2 DRAIN VALVE No. 1 (MOV-SG885) COMMAND	CLOSE	NDO	PLC-SG	HS-SG885D
I08	GRIT WASHER No. 2 DRAIN VALVE No. 2 (MOV-SG886) SWITCH STATUS	IN AUTO	NDI	PLC-SG	HSI-SG865
I08	GRIT WASHER No. 2 DRAIN VALVE No. 2 (MOV-SG886) POSITION	FULLY CLOSED	NDI	PLC-SG	ZIO-SG886B
I08	GRIT WASHER No. 2 DRAIN VALVE No. 2 (MOV-SG886) POSITION	FULLY OPENED	NDI	PLC-SG	ZIC-SG886B
I08	GRIT WASHER No. 2 DRAIN VALVE No. 2 (MOV-SG886) COMMAND	OPEN	NDO	PLC-SG	HS-SG886C
I08	GRIT WASHER No. 2 DRAIN VALVE No. 2 (MOV-SG886) COMMAND	CLOSE	NDO	PLC-SG	HS-SG886D
I08	GRIT WASHER No. 2 STIRRER No. 2 (GM-SG881) SWITCH STATUS	IN AUTO	NDI	PLC-SG	HSI-SG881

DWG	SERVICE DESCRIPTION	STATE/SPAN	TYPE	PLC	TAG
I08	GRIT WASHER No. 2 STIRRER No. 2 (GM-SG881) COMMAND	START/STOP	NDO	PLC-SG	HS-SG881
I08	GRIT WASHER No. 2 STIRRER No. 2 (GM-SG881) STATUS	RUNNING	NDI	PLC-SG	YN-SG881
I08	GRIT WASHER No. 2 STIRRER No. 2 (GM-SG881) ALARM	FAIL	NDI	PLC-SG	YA-SG881A
I08	GRIT WASHER No. 2 STIRRER No. 2 (GM-SG881) ALARM	FAIL TO START	NDI	PLC-SG	YA-SG881B
I08	GRIT WASHER No. 2 STIRRER No. 2 (GM-SG881) ALARM	E-STOP ACTIVATED	NDI	PLC-SG	YA-SG881C
I08	GRIT WASHER No. 2 (GM-SG881) LEVEL	LEVEL	NAI	PLC-SG	LIR-SG881
I07B	GRIT WASHER No. 2 SCREW No. 2 (GM-SG883) SWITCH STATUS	IN AUTO	NDI	PLC-SG	HSI-SG883
I08	GRIT WASHER No. 2 SCREW No. 2 (GM-SG883) COMMAND	START/STOP	NDO	PLC-SG	HS-SG883
I08	GRIT WASHER No. 2 SCREW No. 2 (GM-SG883) STATUS	RUNNING	NDI	PLC-SG	YN-SG883
I08	GRIT WASHER No. 2 SCREW No. 2 (GM-SG883) ALARM	FAIL	NDI	PLC-SG	YA-SG883A
I08	GRIT WASHER No. 2 SCREW No. 2 (GM-SG883) ALARM	FAIL TO START	NDI	PLC-SG	YA-SG883B
I08	GRIT WASHER No. 2 SCREW No. 2 (GM-SG883) ALARM	E-STOP ACTIVATED	NDI	PLC-SG	YA-SG883C
ODOR CONTROL SYSTEM					
I09	MIST ELIMINATOR No. 1 (F-SG911) DIFFERENTIAL PRESSURE	SEE SECTION 17910	AI	PLC-SG	DPIR-SG911
I09	MIST ELIMINATOR No. 1 (F-SG911) DIFFERENTIAL PRESSURE ALARM	HIGH	DI	PLC-SG	DPAH-SG911
I09	MIST ELIMINATOR No. 2 (F-SG921) DIFFERENTIAL PRESSURE	SEE SECTION 17910	AI	PLC-SG	DPIR-SG921

DWG	SERVICE DESCRIPTION	STATE/SPAN	TYPE	PLC	TAG
I09	MIST ELIMINATOR No. 2 (F-SG921) DIFFERENTIAL PRESSURE ALARM	HIGH	DI	PLC-SG	DPAH-SG921
I09	CARBON VESSEL No. 1 (F-SG919) BOTTOM MEDIA DIFFERENTIAL PRESSURE	SEE SECTION 17910	AI	PLC-SG	DPIR-SG919A
I09	CARBON VESSEL No. 1 (F-SG919) BOTTOM MEDIA DIFFERENTIAL PRESSURE ALARM	HIGH	DI	PLC-SG	DPAH-SG919A
I09	CARBON VESSEL No. 1 (F-SG919) TOP MEDIA DIFFERENTIAL PRESSURE	SEE SECTION 17910	AI	PLC-SG	DPIR-SG919B
I09	CARBON VESSEL No. 1 (F-SG919) TOP MEDIA DIFFERENTIAL PRESSURE ALARM	HIGH	DI	PLC-SG	DPAH-SG919B
I09	CARBON VESSEL No. 2 (F-SG929) BOTTOM MEDIA DIFFERENTIAL PRESSURE	SEE SECTION 17910	AI	PLC-SG	DPIR-SG929A
I09	CARBON VESSEL No. 2 (F-SG929) BOTTOM MEDIA DIFFERENTIAL PRESSURE ALARM	HIGH	DI	PLC-SG	DPAH-SG929A
I09	CARBON VESSEL No. 2 (F-SG929) TOP MEDIA DIFFERENTIAL PRESSURE	SEE SECTION 17910	AI	PLC-SG	DPIR-SG929B
I09	CARBON VESSEL No. 2 (F-SG929) TOP MEDIA DIFFERENTIAL PRESSURE ALARM	HIGH	DI	PLC-SG	DPAH-SG929B
I09	ODOR CONTROL FAN No. 1 (F-SG915) STATUS	RUNNING	DI	PLC-SG	YN-SG915
I09	ODOR CONTROL FAN No. 1 (F-SG915) MOTOR ALARM	FAULT	DI	PLC-SG	YA-SG915A
I09	ODOR CONTROL FAN No. 1 (F-SG915) VFD ALARM	FAULT	DI	PLC-SG	YA-SG915B
I09	ODOR CONTROL FAN No. 1 (F-SG915) SWITCH STATUS	E-STOP ACTIVATED	DI	PLC-SG	HSI-SG915B
I09	ODOR CONTROL FAN No. 1 (F-SG915) HIGH PRESSURE ALARM	HIGH DISCHARGE	DI	PLC-SG	PAH-SG915
I09	ODOR CONTROL FAN No. 1 (F-SG915) LOW PRESSURE ALARM	LOW SUCTION PRESSURE	DI	PLC-SG	PAL-SG915
I09	ODOR CONTROL FAN No. 1 (F-SG915) SPEED FEEDBACK	0-100 %	AI	PLC-SG	SI-SG915
I09	ODOR CONTROL FAN No. 2 (F-SG925) STATUS	RUNNING	DI	PLC-SG	YN-SG925
I09	ODOR CONTROL FAN No. 2 (F-SG925) MOTOR ALARM	FAULT	DI	PLC-SG	YA-SG925A

DWG	SERVICE DESCRIPTION	STATE/SPAN	TYPE	PLC	TAG
I09	ODOR CONTROL FAN No. 2 (F-SG925) VFD ALARM	FAULT	DI	PLC-SG	YA-SG925B
I09	ODOR CONTROL FAN No. 2 (F-SG925) SWITCH STATUS	E-STOP ACTIVATED	DI	PLC-SG	HSI-SG925B
I09	ODOR CONTROL FAN No. 2 (F-SG925) HIGH PRESSURE ALARM	HIGH DISCHARGE	DI	PLC-SG	PAH-SG925
I09	ODOR CONTROL FAN No. 2 (F-SG925) ALARM	LOW SUCTION PRESSURE	DI	PLC-SG	PAL-SG925
I09	ODOR CONTROL FAN No. 2 (F-SG925) SPEED FEEDBACK	0-100 %	AI	PLC-SG	SI-SG925
ODOR CONTROL GAS MONITORING					
I10	TOXIC GAS SENSOR (H2S) (AE-SG991) ALARM	FAULT	DI	PLC-SG	YA-SG991
I10	TOXIC GAS SENSOR (AE-SG991) ALARM	HIGH LEVEL	DI	PLC-SG	LAH-SG991
I10	TOXIC GAS SENSOR (AE-SG991) LEVEL	SEE SECTION 17910	AI	PLC-SG	LI-SG991
I10	OXYGEN GAS SENSOR (AE-SG992) ALARM	FAULT	DI	PLC-SG	YA-SG992
I10	OXYGEN GAS SENSOR (AE-SG992) ALARM	HIGH LEVEL	DI	PLC-SG	LAH-SG992
I10	OXYGEN GAS SENSOR (AE-SG992) LEVEL	SEE SECTION 17910	AI	PLC-SG	LI-SG992
I10	COMBUSTIBLE GAS SENSOR (AE-SG993) ALARM	FAULT	DI	PLC-SG	YA-SG993
I10	COMBUSTIBLE GAS SENSOR (AE-SG993) ALARM	HIGH LEVEL	DI	PLC-SG	LAH-SG993
I10	COMBUSTIBLE GAS SENSOR (AE-SG993) LEVEL	SEE SECTION 17910	AI	PLC-SG	LI-SG993
I10	GAS MONITORING PANEL HORN CONTROL	SILENCE	DO	PLC-SG	HS-SG990

DWG	SERVICE DESCRIPTION	STATE/SPAN	TYPE	PLC	TAG
MISCELLANEOUS					
I10	ODOR CONTROL ROOM LEVEL ALARM	FLOOD	DI	PLC-SG	LAH-SG959
I10	SOUTH GRIT PUMP DRYWELL SUMP PUMP STATION HIGH LEVEL	ALARM	DI	PLC-SG	LAHH-SG950
I10	SOUTH GRIT PUMP DRYWELL SUMP PUMP No. 1 STATUS	RUNNING	DI	PLC-SG	YN-SG951
I10	SOUTH GRIT PUMP DRYWELL SUMP PUMP No. 1 FAULT	ALARM	DI	PLC-SG	YA-SG951
I10	SOUTH GRIT PUMP DRYWELL SUMP PUMP No. 2 STATUS	RUNNING	DI	PLC-SG	YN-SG952
I10	SOUTH GRIT PUMP DRYWELL SUMP PUMP No. 2 FAULT	ALARM	DI	PLC-SG	YA-SG952
I10	NORTH GRIT AUGER DRYWELL SUMP PUMP STATION HIGH LEVEL	ALARM	DI	PLC-SG	LAHH-SG960
I10	NORTH GRIT AUGER DRYWELL SUMP PUMP No. 1 STATUS	RUNNING	DI	PLC-SG	YN-SG961
I10	NORTH GRIT AUGER DRYWELL SUMP PUMP No. 1 FAULT	ALARM	DI	PLC-SG	YA-SG961
I10	NORTH GRIT AUGER DRYWELL SUMP PUMP No. 2 STATUS	RUNNING	DI	PLC-SG	YN-SG962
I10	NORTH GRIT AUGER DRYWELL SUMP PUMP No. 2 FAULT	ALARM	DI	PLC-SG	YA-SG962
I10	NORTH DUMPSTER ROOM SUMP PUMP STATION HIGH LEVEL	ALARM	DI	PLC-SG	LAHH-SG970
I10	NORTH DUMPSTER ROOM SUMP PUMP No. 1 STATUS	RUNNING	DI	PLC-SG	YN-SG971
I10	NORTH DUMPSTER ROOM SUMP PUMP No. 1 FAULT	ALARM	DI	PLC-SG	YA-SG971
I10	NORTH DUMPSTER ROOM SUMP PUMP No. 2 STATUS	RUNNING	DI	PLC-SG	YN-SG972
I10	NORTH DUMPSTER ROOM SUMP PUMP No. 2 FAULT	ALARM	DI	PLC-SG	YA-SG972
I10	LOWER ALCOVE AREA SUMP PUMP STATION HIGH LEVEL	ALARM	DI	PLC-SG	LAHH-SG980
I10	LOWER ALCOVE AREA SUMP PUMP No. 1 STATUS	RUNNING	DI	PLC-SG	YN-SG981
I10	LOWER ALCOVE AREA SUMP PUMP No. 1 FAULT	ALARM	DI	PLC-SG	YA-SG981
I10	LOWER ALCOVE AREA SUMP PUMP No. 2 STATUS	RUNNING	DI	PLC-SG	YN-SG982
I10	LOWER ALCOVE AREA SUMP PUMP No. 2 FAULT	ALARM	DI	PLC-SG	YA-SG982

DWG	SERVICE DESCRIPTION	STATE/SPAN	TYPE	PLC	TAG
I10	SOUTH GARAGE SUMP PUMP STATION HIGH LEVEL	ALARM	DI	PLC-SG	LAHH-SG990
I10	SOUTH GARAGE SUMP PUMP No. 1 STATUS	RUNNING	DI	PLC-SG	YN-SG991
I10	SOUTH GARAGE SUMP PUMP No. 1 FAULT	ALARM	DI	PLC-SG	YA-SG991
I10	SOUTH GARAGE SUMP PUMP No. 2 STATUS	RUNNING	DI	PLC-SG	YN-SG992
I10	SOUTH GARAGE SUMP PUMP No. 2 FAULT	ALARM	DI	PLC-SG	YA-SG992

Notes:

1. Input / Output types are as follows:

- DI - Discrete Input
- DO - Discrete Output
- AI - Analog Input
- AO - Analog Output
- NDI - Network Discrete Input
- NDO - Network Discrete Output
- NAI - Network Analog Input
- NAO - Network Analog Output

- END OF SECTION -

APPENDIX

CITY OF ANN ARBOR LIVING WAGE ORDINANCE DECLARATION OF COMPLIANCE

The Ann Arbor Living Wage Ordinance (Section 1:811-1:821 of Chapter 23 of Title I of the Code) requires that an employer who is (a) a contractor providing services to or for the City for a value greater than \$10,000 for any twelve-month contract term, or (b) a recipient of federal, state, or local grant funding administered by the City for a value greater than \$10,000, or (c) a recipient of financial assistance awarded by the City for a value greater than \$10,000, shall pay its employees a prescribed minimum level of compensation (i.e., Living Wage) for the time those employees perform work on the contract or in connection with the grant or financial assistance. The Living Wage must be paid to these employees for the length of the contract/program.

Companies employing fewer than 5 persons and non-profits employing fewer than 10 persons are exempt from compliance with the Living Wage Ordinance. If this exemption applies to your company/non-profit agency please check here No. of employees__

The Contractor or Grantee agrees:

- (a) To pay each of its employees whose wage level is not required to comply with federal, state or local prevailing wage law, for work covered or funded by a contract with or grant from the City, no less than the Living Wage. The current Living Wage is defined as \$14.05/hour for those employers that provide employee health care (as defined in the Ordinance at Section 1:815 Sec. 1 (a)), or no less than \$15.66/hour for those employers that do not provide health care. The Contractor or Grantor understands that the Living Wage is adjusted and established annually on April 30 in accordance with the Ordinance and covered employers shall be required to pay the adjusted amount thereafter to be in compliance with Section 1:815(3).

Check the applicable box below which applies to your workforce

Employees who are assigned to any covered City contract/grant will be paid at or above the applicable living wage without health benefits

Employees who are assigned to any covered City contract/grant will be paid at or above the applicable living wage with health benefits

- (b) To post a notice approved by the City regarding the applicability of the Living Wage Ordinance in every work place or other location in which employees or other persons contracting for employment are working.
- (c) To provide to the City payroll records or other documentation within ten (10) business days from the receipt of a request by the City.
- (d) To permit access to work sites to City representatives for the purposes of monitoring compliance, and investigating complaints or non-compliance.
- (e) To take no action that would reduce the compensation, wages, fringe benefits, or leave available to any employee covered by the Living Wage Ordinance or any person contracted for employment and covered by the Living Wage Ordinance in order to pay the living wage required by the Living Wage Ordinance.

The undersigned states that he/she has the requisite authority to act on behalf of his/her employer in these matters and has offered to provide the services or agrees to accept financial assistance in accordance with the terms of the Living Wage Ordinance. The undersigned certifies that he/she has read and is familiar with the terms of the Living Wage Ordinance, obligates the Employer/Grantee to those terms and acknowledges that if his/her employer is found to be in violation of Ordinance it may be subject to civil penalties and termination of the awarded contract or grant of financial assistance.

Company Name

Street Address

Signature of Authorized Representative

Date

City, State, Zip

Print Name and Title

Phone/Email address

CITY OF ANN ARBOR LIVING WAGE ORDINANCE

RATE EFFECTIVE APRIL 30, 2021 - ENDING APRIL 29, 2022

\$14.05 per hour

If the employer provides health care benefits*

\$15.66 per hour

If the employer does **NOT** provide health care benefits*

Employers providing services to or for the City of Ann Arbor or recipients of grants or financial assistance from the City of Ann Arbor for a value of more than \$10,000 in a twelve-month period of time must pay those employees performing work on a City of Ann Arbor contract or grant, the above living wage.

ENFORCEMENT

The City of Ann Arbor may recover back wages either administratively or through court action for the employees that have been underpaid in violation of the law. Persons denied payment of the living wage have the right to bring a civil action for damages in addition to any action taken by the City.

Violation of this Ordinance is punishable by fines of not more than \$500/violation plus costs, with each day being considered a separate violation. Additionally, the City of Ann Arbor has the right to modify, terminate, cancel or suspend a contract in the event of a violation of the Ordinance.

* Health Care benefits include those paid for by the employer or making an employer contribution toward the purchase of health care. The employee contribution must not exceed \$.50 an hour for an average work week; and the employer cost or contribution must equal no less than \$1/hr. for the average work week.

The Law Requires Employers to Display This Poster Where Employees Can Readily See It.

**For Additional Information or to File a Complaint contact
Colin Spencer at 734/794-6500 or cspencer@a2gov.org**



Vendor Conflict of Interest Disclosure Form
--

All vendors interested in conducting business with the City of Ann Arbor must complete and return the Vendor Conflict of Interest Disclosure Form in order to be eligible to be awarded a contract. Please note that all vendors are subject to comply with the City of Ann Arbor’s conflict of interest policies as stated within the certification section below.

If a vendor has a relationship with a City of Ann Arbor official or employee, an immediate family member of a City of Ann Arbor official or employee, the vendor shall disclose the information required below.

1. No City official or employee or City employee’s immediate family member has an ownership interest in vendor’s company or is deriving personal financial gain from this contract.
2. No retired or separated City official or employee who has been retired or separated from the City for less than one (1) year has an ownership interest in vendor’s Company.
3. No City employee is contemporaneously employed or prospectively to be employed with the vendor.
4. Vendor hereby declares it has not and will not provide gifts or hospitality of any dollar value or any other gratuities to any City employee or elected official to obtain or maintain a contract.
5. Please note any exceptions below:

Conflict of Interest Disclosure*	
Name of City of Ann Arbor employees, elected officials or immediate family members with whom there may be a potential conflict of interest.	<input type="checkbox"/> Relationship to employee <hr style="border: 0; border-top: 1px solid black;"/> <input type="checkbox"/> Interest in vendor’s company <input type="checkbox"/> Other (please describe in box below)

*Disclosing a potential conflict of interest does not disqualify vendors. In the event vendors do not disclose potential conflicts of interest and they are detected by the City, vendor will be exempt from doing business with the City.

I certify that this Conflict of Interest Disclosure has been examined by me and that its contents are true and correct to my knowledge and belief and I have the authority to so certify on behalf of the Vendor by my signature below:		
Vendor Name	Vendor Phone Number	
Signature of Vendor Authorized Representative	Date	Printed Name of Vendor Authorized Representative

CITY OF ANN ARBOR NON-DISCRIMINATION ORDINANCE

Relevant provisions of Chapter 112, Nondiscrimination, of the Ann Arbor City Code are included below.
You can review the entire ordinance at www.a2gov.org/humanrights.

Intent: It is the intent of the city that no individual be denied equal protection of the laws; nor shall any individual be denied the enjoyment of his or her civil or political rights or be discriminated against because of actual or perceived age, arrest record, color, disability, educational association, familial status, family responsibilities, gender expression, gender identity, genetic information, height, HIV status, marital status, national origin, political beliefs, race, religion, sex, sexual orientation, source of income, veteran status, victim of domestic violence or stalking, or weight.

Discriminatory Employment Practices: No person shall discriminate in the hire, employment, compensation, work classifications, conditions or terms, promotion or demotion, or termination of employment of any individual. No person shall discriminate in limiting membership, conditions of membership or termination of membership in any labor union or apprenticeship program.

Discriminatory Effects: No person shall adopt, enforce or employ any policy or requirement which has the effect of creating unequal opportunities according to actual or perceived age, arrest record, color, disability, educational association, familial status, family responsibilities, gender expression, gender identity, genetic information, height, HIV status, marital status, national origin, political beliefs, race, religion, sex, sexual orientation, source of income, veteran status, victim of domestic violence or stalking, or weight for an individual to obtain housing, employment or public accommodation, except for a bona fide business necessity. Such a necessity does not arise due to a mere inconvenience or because of suspected objection to such a person by neighbors, customers or other persons.

Nondiscrimination by City Contractors: All contractors proposing to do business with the City of Ann Arbor shall satisfy the contract compliance administrative policy adopted by the City Administrator in accordance with the guidelines of this section. All city contractors shall ensure that applicants are employed and that employees are treated during employment in a manner which provides equal employment opportunity and tends to eliminate inequality based upon any classification protected by this chapter. All contractors shall agree not to discriminate against an employee or applicant for employment with respect to hire, tenure, terms, conditions, or privileges of employment, or a matter directly or indirectly related to employment, because of any applicable protected classification. All contractors shall be required to post a copy of Ann Arbor's Non-Discrimination Ordinance at all work locations where its employees provide services under a contract with the city.

Complaint Procedure: If any individual believes there has been a violation of this chapter, he/she may file a complaint with the City's Human Rights Commission. The complaint must be filed within 180 calendar days from the date of the individual's knowledge of the allegedly discriminatory action or 180 calendar days from the date when the individual should have known of the allegedly discriminatory action. A complaint that is not filed within this timeframe cannot be considered by the Human Rights Commission. To file a complaint, first complete the complaint form, which is available at www.a2gov.org/humanrights. Then submit it to the Human Rights Commission by e-mail (hrc@a2gov.org), by mail (Ann Arbor Human Rights Commission, PO Box 8647, Ann Arbor, MI 48107), or in person (City Clerk's Office). For further information, please call the commission at 734-794-6141 or e-mail the commission at hrc@a2gov.org.

Private Actions For Damages or Injunctive Relief: To the extent allowed by law, an individual who is the victim of discriminatory action in violation of this chapter may bring a civil action for appropriate injunctive relief or damages or both against the person(s) who acted in violation of this chapter.

THIS IS AN OFFICIAL GOVERNMENT NOTICE AND
MUST BE DISPLAYED WHERE EMPLOYEES CAN READILY SEE IT.

Date _____

I, _____ (Name of Signatory Party) _____ (Title)

do hereby state:

(1) That I pay or supervise the payment of the persons employed by

_____ on the
 _____ (Contractor or Subcontractor)
 _____; that during the payroll period commencing on the
 _____ (Building or Work)
 _____ day of _____, _____, and ending the _____ day of _____, _____,
 all persons employed on said project have been paid the full weekly wages earned, that no rebates have
 been or will be made either directly or indirectly to or on behalf of said

_____ from the full
 _____ (Contractor or Subcontractor)
 weekly wages earned by any person and that no deductions have been made either directly or indirectly
 from the full wages earned by any person, other than permissible deductions as defined in Regulations, Part
 3 (29 C.F.R. Subtitle A), issued by the Secretary of Labor under the Copeland Act, as amended (48 Stat. 948,
 63 Stat. 108, 72 Stat. 967; 76 Stat. 357; 40 U.S.C. § 3145), and described below:

(2) That any payrolls otherwise under this contract required to be submitted for the above period are
 correct and complete; that the wage rates for laborers or mechanics contained therein are not less than the
 applicable wage rates contained in any wage determination incorporated into the contract; that the
 classifications set forth therein for each laborer or mechanic conform with the work he performed.

(3) That any apprentices employed in the above period are duly registered in a bona fide
 apprenticeship program registered with a State apprenticeship agency recognized by the Bureau of
 Apprenticeship and Training, United States Department of Labor, or if no such recognized agency exists in a
 State, are registered with the Bureau of Apprenticeship and Training, United States Department of Labor.

(4) That:

(a) WHERE FRINGE BENEFITS ARE PAID TO APPROVED PLANS, FUNDS, OR PROGRAMS

- in addition to the basic hourly wage rates paid to each laborer or mechanic listed in
 the above referenced payroll, payments of fringe benefits as listed in the contract
 have been or will be made to appropriate programs for the benefit of such
 employees, except as noted in section 4(c) below.

(b) WHERE FRINGE BENEFITS ARE PAID IN CASH

- Each laborer or mechanic listed in the above referenced payroll has been paid,
 as indicated on the payroll, an amount not less than the sum of the applicable
 basic hourly wage rate plus the amount of the required fringe benefits as listed
 in the contract, except as noted in section 4(c) below.

(c) EXCEPTIONS

EXCEPTION (CRAFT)	EXPLANATION

REMARKS:

NAME AND TITLE	SIGNATURE

THE WILLFUL FALSIFICATION OF ANY OF THE ABOVE STATEMENTS MAY SUBJECT THE CONTRACTOR OR
 SUBCONTRACTOR TO CIVIL OR CRIMINAL PROSECUTION. SEE SECTION 1001 OF TITLE 18 AND SECTION 231 OF TITLE
 31 OF THE UNITED STATES CODE.

ATTACHMENTS

Attachment A – Waterman Slide Gate O&M Manual

**MALCOLM
PIRNIE**



**SUBMITTAL REVIEW
COMMENT FORM**

11287-0006-A

The Water Division of ARCADIS

To: William Gilliam	From: Tom Porter
Firm: Walsh Construction Company II, LLC 3011 W. Grand Boulevard Detroit, MI 48202	Firm: Malcolm Pirnie of Michigan, Inc. 1001 Woodward Avenue Suite 1000 Detroit, MI 48226
Ph: (313) 873-6600	Ph: (313) 965-8436
Fax: (313) 873-6633	Fax: (313) 965-8907
Date: March 11, 2016	Project: Ann Arbor Waste Water Treatment Plant Facilities Renovations Project

File No.: 11287-0006-A
Slide Gates – Final O&M Manual

SUBMITTAL REVIEW COMMENTS:

1. This submittal is coded "Approved."

Cc:

Signed: *Brian R. Curson*



1001 Woodward Ave
 Suite 1000
 Detroit, MI 48226
 Phone: 313-965-8436
 Fax: 313-965-8907

Letter of Transmittal

PROJECT: AA WWTP Facilities Renovation
 3185013

DATE: 3/11/2016

TO: Walsh Construction Company
 3011 W. Grand Boulevard
 Suite 2300
 Detroit, MI 48202

REF: MPI/WCC Lot No. 02434
 11287-0006-A Slide Gates-Final
 OM

ATTN: Bill Gilliam

WE ARE SENDING:	SUBMITTED FOR:
<input checked="" type="checkbox"/> Shop Drawings	<input type="checkbox"/> Approval
<input type="checkbox"/> Letter	<input checked="" type="checkbox"/> Your Use
<input type="checkbox"/> Prints	<input type="checkbox"/> As Requested
<input type="checkbox"/> Change Order	<input type="checkbox"/> Review and Comment
<input type="checkbox"/> Plans	
<input type="checkbox"/> Samples	SENT VIA:
<input type="checkbox"/> Specifications	<input checked="" type="checkbox"/> Attached
<input type="checkbox"/> Other:	<input type="checkbox"/> Separate Cover Via

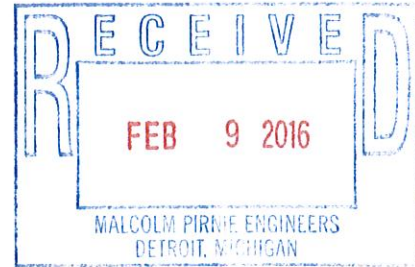
ITEM NO.	COPIES	DATE	DESCRIPTION
01	01	03/11/16	11287-0006-A Slide Gates-Final OM

Remarks:

Signed: 
 Thomas G. Porter



Walsh Construction



ANN ARBOR
WASTEWATER TREATMENT PLANT
FACILITIES RENOVATIONS

ITB No. 4191

MPI Project No. 03185013.0002

SUBMITTAL NO. 11287-0006-A

Approved
 Approved as Corrected
 Approved as Corrected Resubmit
 Revise and Resubmit
 Not Approved
 For Information Only

MALCOLM PIRNIE OF MICHIGAN, INC.

Date 3/11/16 By B.R.C./TGP

Project Name: Ann Arbor WWTP
Facilities Renovations

Contractor's Name: Walsh Construction
Company II, LLC

Date: 2/8/16

Item/Sub. Title: Slide Gate Final O&M's

Specifications:

Section: 11289

Page No.: 3

Paragraph No.: 1.4

Drawing No.: _____

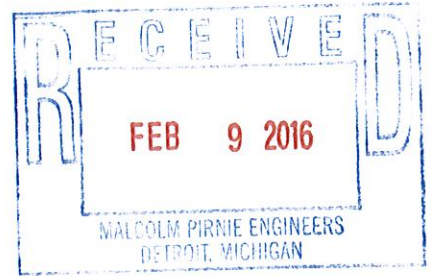
Location of Work: AAWWTP

Submittal No. & Review Cycle: 11287-0006-A

Coordinated with Submittal Nos.: _____

I hereby certify that the Contractor has satisfied Contractor's obligations under the Contract Documents relative to Contractor's review and approval of this submittal.

Approved By (for Contractor): [Signature]



**OPERATION AND MAINTENANCE INSTRUCTIONS
SPECIFICATION 11287 SLIDE GATES**

**EQUIPMENT:
WATERMAN FABRICATED STAINLESS STEEL SLIDE GATES
RETRO-FIT ACTUATORS FOR EXISTING SLIDE GATES**

Influent Splitter, East & West Aeration Tanks, Screen & Grit Building

**FOR:
ANN ARBOR WWTP
ANN ARBOR, MICHIGAN**

**MANUFACTURED BY: WATERMAN INDUSTRIES, INC
25500 ROAD 204
EXETER, CA 93221
PHONE: (559) 562-4000**

REF: WATERMAN JOB # A19418L

**SERVICE: ARRANGED THROUGH THE FACTORY
PHONE: (559) 562-4000
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CONTACT: Danny White**

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TRANSMITTAL
TRNS-02523
 CITY OF ANN ARBOR
 Contract # ITB No. 4191
 Project #

Date: February 8, 2016

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Submittal Info:

Line	Qty	Submittal No.	Review Cycle	Spec Section	Sub Section	Description	Type	Status
1	4	11287-0006-A	1	11287	1.4.A	Final O&M - Slide Gates	Operations/ Maintenance Manuals	Submitted for Approval

Due Date: February 22, 2016

CC: **Project Contact:** **Project Partner:**
 Project File

Remarks:

Signature: _____

Signature Date: _____



Walsh Construction

ANN ARBOR
WASTEWATER TREATMENT PLANT
FACILITIES RENOVATIONS

ITB No. 4191


MPI Project No. 03185013.0002

SUBMITTAL NO. _____

- Approved
- Approved as Corrected
- Approved as Corrected Resubmit
- Revise and Resubmit
- Not Approved
- For Information Only

MALCOLM PIRNIE OF MICHIGAN, INC.

Date _____ By _____

Project Name:	<u>Ann Arbor WWTP Facilities Renovations</u>
Contractor's Name:	<u>Walsh Construction Company II, LLC</u>
Date:	<u>2/8/16</u>
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OPERATION AND MAINTENANCE MANUAL

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WATERMAN INDUSTRIES

FOREWORD

The purpose of this manual is to provide information to the engineers, contractors, plant operators and associated personnel involved with the installation, operation and maintenance of equipment supplied by **WATERMAN INDUSTRIES** for this project. Although every care is taken in our factory to ensure top quality equipment, we cannot be responsible for damage caused by negligence after shipping. Therefore, described herein are **WATERMAN INDUSTRIES** recommended methods of handling, storage, installation, adjustment, and initial operation for standard situations to be used in conjunction with the approved installation drawings provided by **WATERMAN INDUSTRIES**. If proper care and accuracy are exercised in the field when installing our gates, they will operate as designed at maximum efficiency.

WATERMAN INDUSTRIES

RECEIVING

CHECK COUNT all parts when you receive shipment. All individually shipped parts or assemblages are listed on the packing list(s). Should a shortage exist, notify **WATERMAN INDUSTRIES** immediately. We cannot be responsible for any shortages reported more than 30 days after receipt of shipment. Special care should be taken in accounting for and safely storing all bolts, nuts, and small items, which are often misplaced at jobsites.

Unless your contract with **WATERMAN INDUSTRIES** states otherwise, all equipment is shipped F.O.B. factory. If any equipment has been damaged in transit, the purchaser will be responsible for filing claim with the transportation company. For assistance in filing any claim and/or replacing equipment, please contact **WATERMAN INDUSTRIES** directly.

WATERMAN INDUSTRIES

HANDLING AND STORAGE

All WATERMAN INDUSTRIES gates and appurtenances are precision machinery and should be handled accordingly. While all parts are of rugged design, it is still possible to warp machined surfaces, stems, etc., through improper storage and handling. To avoid all problems of this nature we recommend the following:

1. Lift gates through stem hole in top of lift nut box on cover only when shipping stops are in place, taking particular care of wedges and seats.
2. Support full length of stems at all times, being sure not to damage threads.
3. Store equipment on an even, clean, dry surface to prevent distortion.
4. Cover all equipment to protect machined surfaces.
5. **DO NOT** stack equipment without protection and proper spacers.
6. Handle lifts as you would any precision machinery.

WATERMAN INDUSTRIES

STORAGE OF ELECTRIC MOTOR OPERATORS - (SHORT TERM-UP TO 1 YEAR)

Electric motor operators are more susceptible to the elements than manual lifts and thus require greater protection prior to full installation.

NOTE: Operators are not weatherproof until properly installed or prepared for storage. Lifts should not be installed prior to time electricity is available at jobsite. Lifts should be stored in a clean, dry, protected warehouse, free from excessive vibration and rapid temperature changes. Conduit plugs and limit switch compartments should not be opened until lifts are hooked up electrically.

If actuators must be stored outdoors, they must be stored off the ground, high enough to prevent their being immersed in water or buried by snow, and covered with tarps. Unit should be stored with motor shaft horizontal and limit switch compartment cover in vertical position.

WATERMAN INDUSTRIES

STORAGE OF ELECTRIC MOTOR OPERATORS (LONG TERM)

1.0 OBJECTIVE

The following are our recommendations of storage procedures to retain maximum product integrity during long term storage of 1 to 5 years.

2.0 LOCATION

Actuators to be stored in a clean, dry, protected warehouse free from excessive vibration and rapid temperature changes.

NOTE: The maximum source of equipment deterioration anticipated during long term storage is from possible condensation within the actuator enclosure that may be produced by rapid temperature changes in the storage environment. Should reliable means not be available to prevent rapid temperature changes, the user should consider the addition of heat sources in the electrical enclosures during storage.

3.0 EQUIPMENT ORIENTATION

- 3.1 The preferred storage position is with the valve stem and motor shaft in the horizontal position and the actuator or limit switch compartment cover in vertical position.
- 3.2 An acceptable alternate position is with the valve stem vertical, the motor shaft horizontal, and the limit switch compartment cover either facing to the side or vertically up.
- 3.3 The assembly shall be stored off the floor on suitable skids and shall be covered with an unsealed dust cover with the bottom open and air holes in the side.

4.0 STORAGE PREPARATION, INSPECTION AND MAINTENANCE

- 4.1 For storage situations of 1 to 2 years maximum, spray electric contacts with CRC #2-26. (This preservative does not have to be removed prior to usage of the actuator.)
- 4.2 For storage situations between 2 and 5 years, spray electric contacts with CRC Lectra Shield spray coating. (This coating must be removed with suitable cleaner, such as any standard petroleum solvent, prior to making electrical connections.)

4.3 STORAGE INSPECTION

- 4.3.1 Visual inspection shall be performed on a semi-annual basis and results recorded.
- 4.3.2 Visual inspection as a minimum shall include checking packaging, plugs, covers, dryness, cleanliness, and the proper function of heat sources (when used).

4.4 MAINTENANCE

Maintenance shall consist of correcting deficiencies noted during inspection and all maintenance activity recorded.

WATERMAN INDUSTRIES

STORAGE OF ACTUATORS MOUNTED ON VALVES INSTALLED IN PIPELINES

1.0A LOCATION

Actuators to be stored mounted on valves installed in the pipelines within a partially completed structure, which protects them from direct exposure to the elements. Protection should be provided to the units to prevent accumulation of abrasive particles from collecting at external moving parts of the actuator. This could be accomplished by means of an unsealed dust cover with the bottom open and air holes in the side, or alternately by means of application of a readily peelable rust preventative at the moving areas such as drive sleeve, handwheel shaft and declutch shaft.

NOTE: The maximum source of equipment deterioration anticipated during long-term storage is from possible condensation within the actuator enclosure, which may be produced by rapid temperature changes. Should reliable means not be available to prevent rapid temperature changes, the user should consider the addition of heat sources in the electrical enclosures during storage.

2.0A EQUIPMENT ORIENTATION

- 2.1 The preferred storage position is with the valve stem and motor shaft in the horizontal position and the actuator limit switch compartment cover in the vertical position.
- 2.2 An acceptable alternate position is with the valve stem vertical, the motor shaft horizontal and the limit switch compartment cover either facing to the side or vertical.
- 2.3 Although the mounting positions listed in 2.1 and 2.2 are preferable, it is not always possible to attain when physically mounted in the pipeline. It should also be appreciated that the internal pressure of the unit would fluctuate slightly above and below atmospheric pressure, possibly permitting some oil (separated from the grease on the unit) to migrate through the seals at the bottom of the unit. It is possible that some oil may appear in the limit switch compartment, should it be facing down. This is not a malfunction and should merely be cleaned before pressing the units into service.

WATERMAN INDUSTRIES

STORAGE OF ACTUATORS MOUNTED ON VALVES INSTALLED IN PIPELINES - (CONTINUED)

3.0 STORAGE PREPARATION, INSPECTION AND MAINTENANCE

- 3.1 For storage situations of 1 to 2 years maximum, spray electric contacts with CRC #2-26. (This preservative does not have to be removed prior to usage of the actuator.)

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3.4 MAINTENANCE

Maintenance shall consist of correcting deficiencies noted during inspection and all maintenance activity recorded.

3.5 ADDITIONAL STORAGE INFORMATION

In addition to steps 3.1 through 3.4, since the units would be in an active construction area, access ports to the actuator, such as the limit switch compartment cover, should be opened only when necessary and then closed as rapidly as possible to minimize ingress of foreign materials. Care should be exercised to replace damaged gaskets and to tighten all bolts.

WATERMAN INDUSTRIES

PROCEDURE FOR INSTALLING A FLATBACK OR FLANGEBACK ON A CONCRETE HEADWALL

1. Secure all anchor bolts in proper position in the forms, checking carefully to see that size, projection, perpendicular, and horizontal alignment conform to requirements shown on our installation drawings. **EXTREME CARE MUST** be exercised in this initial procedure. Improperly set bolts will cause gate warpage, and therefore, excess leakage between the seating surfaces. **DO NOT FORCE GATE ONTO MISALIGNED BOLTS.**

2. Each bolt has been provided with two nuts and two washers to facilitate proper mounting of the gate. Sufficient grout space must be left for adjustment of the back nut as shown in Figure 1.

NOTE: In this case, the projection specified on our installation drawings normally includes the proper amount of the grout space required.

3. After concrete has been poured and the forms have been stripped, place one nut and washer on each anchor bolt and run down against headwall. **DO NOT DISASSEMBLE GATE FOR INSTALLATION.**

Place the completely assembled gate into position, carefully guiding it onto the anchor bolts. Again, **DO NOT FORCE GATE ONTO MISALIGNED BOLTS.** Place the second nut and washer on each bolt and bring both front and back nuts into finger tight contact with the gate surfaces. Check clearance between seat faces, (from back of gate if possible) with .004" feeler gauge. If gate is seating properly, the gauge will not be admitted at any point. In the event that the gate is not seating properly, check to see if the gate has been warped during installation. If so, adjust nuts on anchor bolts to bring frame flat.

4. After gate is found to be seating properly, carefully dry pack or grout in the gate between frame and headwall using a non-shrink material. Check for voids after this has set and fill in as necessary.
5. Tighten all nuts on anchor bolts uniformly, taking care not to warp gates to conform to uneven surfaces. Gate is now ready for initial operation.

NOTE: In those locations where flangeback gates are used on headwalls without sufficient side or bottom clearance for nut adjustments, anchor bolts are brought through the gate frame to the front face. Special anchors and frame drilling must be provided.

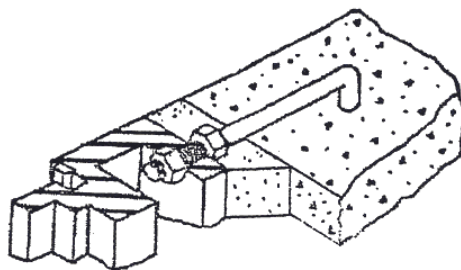


Figure 1

WATERMAN INDUSTRIES

INSTALLATION OF SLIDE GATE TO FACE OF CONCRETE WALL

1. The wall mounted guide frame **MUST BE** set plumb and straight regardless of the condition of the vertical concrete wall on which it is to be mounted. **WATERMAN INDUSTRIES** emphasizes that the guide frame is sufficiently flexible and that it will follow the contour of the wall if all bolts are pulled tight. Grout used in this installation should be of non-shrink type to maintain its seal after curing.
2. Secure all anchor bolts in proper position in forms, checking carefully to see that size, projection, perpendicular and horizontal alignments conform to requirements shown on our installation drawings. **EXTREME CARE** must be exercised in this initial procedure. Improperly set bolts will cause gate warpage and therefore excess leakage between the seating surfaces. **DO NOT FORCE GATE ON TO MISALIGNED BOLTS.** Use guide rail as template.
3. Leveling nuts should be installed on the anchors, checking alignment top to bottom and diagonally to ensure that the outer nut faces are all on the same plane and vertically plumb. The guide frame should be hung loosely on the mounting bolts with the outer nuts to hold it against the leveling nuts, tightening each outer nut a small amount each time until the guide is uniformly against all of the leveling nuts and the outer nuts are tight. The guide should then be checked to ensure that both legs are parallel and plumb.
4. Check the seating perimeter of the gate with a .002" feeler gauge. The gauge should not pass between the seats at any point. If it does, either the seal needs to be adjusted or the frame is out of vertical alignment. The frame can be pulled into alignment by adjusting the leveling nut position adjacent to the area of suspected misalignment.
5. It is recommended that the gate be operated through its full range, open and close, to ensure smooth operation and proper seat contact prior to grouting.
6. Once satisfied that the gate is operating correctly, pack the area between the wall and the gate guide rail with non-shrink grout material.

NOTE: **WATERMAN INDUSTRIES**, specifically discourages the use of any other method of mounting to a concrete wall, including the use of gaskets or mastic materials to seal the gate. These other methods allow the gate frame to conform to the wall surface which, unless absolutely flat, will induce warpage of the gate frame and may cause excessive leakage and/or difficult operation.

7. When the grout has cured, the gate should be thoroughly cleaned of any grout spillage or other debris. Follow all other start-up procedures for operators and stems per the instructions found in other sections of this manual.

WATERMAN INDUSTRIES

PROCEDURE FOR INSTALLING RISING STEMS AND STEM GUIDES

1. Stems are normally shipped with thrust nuts, limit nuts, and couplings attached if so equipped. These must be removed prior to installation.
2. After the gate has been mounted and shipping stops have been removed, lower short-threaded end of stem through holes in upper ribs of cover into contact with the top of the thrust nut.
3. With thrust nut located in gate pocket, thread stem into thrust nut until stem is flush with bottom of nut.
4. Tighten set screws on thrust nut into indents in stem.
5. Mount stem guides in order from bottom up as stem is installed. Do not tighten stem guide assembly bolts. Take care to maintain proper plumb and horizontal orientation.
6. Install stem couplings as required, being sure to install keys. Tighten all set screws, or drive in pins as required.
7. Take care not to bend stems or damage threads during installation¹.
8. Thoroughly clean and grease stem threads with heavy-duty grease, such as Mobilux grease #2EP or equal. (See maintenance section for equivalent greases.)
9. Check final alignment of stem to be sure it is plumb and does not bind. (This should be checked again after installation of lift mechanism.) Stem must be vertically plumb within 1/32" or less.

NOTE: If the gate installation is not vertically plumb, as when mounted on a sloped dam or levee, the stem and operator must be aligned with the plane of gate travel. Standard gates are not designed to mount out of vertical alignment except in a "laid back" position, however, minuscule off-vertical variance can be tolerated provided the stem and operator follow the same variance as the gate. If an installation error occurs where the gate is grossly out of plumb, consult with the factory before installing the stem and operator to determine the best course of action to compensate.

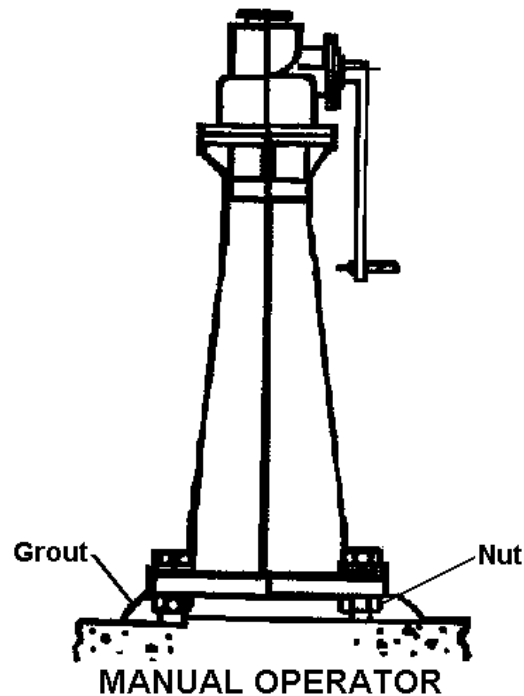
¹ This is especially true on electric motor operated lifts. Extra care should be taken with stems for these operators.

WATERMAN INDUSTRIES

PROCEDURE FOR INSTALLING MANUALLY OPERATED LIFT ON PLATFORM

Lifts are factory lubricated and do not need lubrication at time of installation.

1. Place one nut on each anchor bolt and run down against operating floor, as shown in figure below.
2. After assembling and installing stem, lower the lift over the upper threaded portion of stem, carefully engaging threads of lift nut and stem.
3. By turning handwheel or handcrank, bring base of lift over anchor bolts to about 1" from floor and adjust lower nut by finger turning each nut until it touches pedestal base.
4. Tighten top nuts on anchor bolts and grout in place. Vertical alignment is now correct.
5. Once the lift is properly installed, apply tension to the stem with the lift and align the stem guide. Tighten stem guide assembly bolts.



WATERMAN INDUSTRIES

PROCEDURE FOR INSTALLING ELECTRICALLY OPERATED LIFT ON CONCRETE PLATFORM OR SLAB

1. Place one nut on each anchor bolt and run down against operating floor.
2. After assembling and installing stem, install the operator pedestal, centering stem and leveling with nuts installed in step #1.
3. Lower the operator over the upper threaded portion of stem, carefully engaging threads of lift nut and stem.
4. By turning handwheel or handcrank, bring base of operator down against pedestal top plate, ensuring pilot on bottom of operator engages pilot recess in pedestal. Align operator with mounting holes in pedestal making sure controls and handwheel are conveniently positioned. Install bolts in operator and tighten.
5. Tighten top nuts on anchor bolts and grout in place.
6. Once the lift is properly installed, apply tension to the stem with the lift and align the stem guide, tighten stem guide assembly bolts.

IMPORTANT: Alignment of lift and stem is of critical importance. Double check all components (stem, stem guides, brackets, pedestal, lift, etc.) to ensure all are perfectly aligned.

7. Using emergency handwheel, manually open valve a minimum of three (3) inches prior to using any electrical controls to set actuator. Double check handwheel for proper rotation indication.
8. Connect electrical power and any remote wiring in accordance with wiring diagrams. During wiring installation, should it become necessary to leave unit, close and tighten limit switch compartment and any open conduit taps so as not to leave electrical components unprotected from elements.
9. With the gate open a minimum of three (3) inches, electrically operate gate to check for proper rotation. By having gate open three (3) inches, the direction of rotation can be checked without damaging the stem, stem cover, or hoisting unit, should rotation be wrong. If rotation is incorrect, press **STOP** button immediately and change wired connections appropriately to reverse rotation.
10. Once the unit has been installed, the manufacturer's directions should be followed closely in setting the closing and opening limit switches (See Field Adjustment). The torque switches have been properly set at the factory and should not need adjustment. Follow the manufacturer's instructions if it appears that adjustment is necessary.
11. Lifts are factory lubricated and do not need lubrication at the time of installation.
12. Electric motor operators (actuators) that have travel and torque limit switches do not require limit nuts.

WATERMAN INDUSTRIES

INSTALLATION OF ELECTRIC MOTOR OPERATOR ON SELF-CONTAINED GATES

1. Mount gate and ensure proper alignment of stem. Top surface of headrail(s) must be aligned perpendicular with stem, and stem must pass approximately through center of stem opening in operator pedestal.
2. Lower the lift over the upper threaded portion of stem carefully, engaging threads of lift nut and stem.
3. By turning handwheel or handcrank, bring base over top of bracket and mount with four (4) bolts and nuts. The operator base should fit into pilot recess in top of pedestal. Tighten bolts.
4. Once the lift is properly installed, apply tension to the stem with the lift and align the stem guides. Tighten stem guide assembly bolts.

IMPORTANT: Alignment of lift and stem is of critical importance. Double check all components (stem, stem guides, brackets, pedestal, lift, etc.) to ensure all are perfectly aligned.

5. USING EMERGENCY HANDWHEEL, MANUALLY OPEN VALVE A MINIMUM OF THREE (3) INCHES PRIOR TO USING ANY ELECTRICAL CONTROLS TO SET ACTUATOR. DOUBLE CHECK HANDWHEEL FOR PROPER ROTATION INDICATION.
6. Connect electrical power and any remote wiring in accordance with wiring diagrams. During wiring installation, should it become necessary to leave unit, close and tighten limit switch compartment and any open conduit taps so as not to leave electrical components unprotected from elements.
7. With the gate open a minimum of three (3) inches, electrically operate gate to check for proper rotation. By having gate open three (3) inches, the direction of rotation can be checked without damaging the stem, stem cover, or hoisting unit should rotation be wrong. If rotation is incorrect press **STOP** button immediately and change wired connections appropriately to reverse rotation.
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9. Lifts are factory lubricated and do not need lubrication at the time of installation.
10. Electric motor operators (actuators) that have travel and torque limit switches do not require limit nuts.

WATERMAN INDUSTRIES

INSTALLATION OF LIMIT NUTS

After lift is installed with gate in fully closed position, screw limit nut down on stem until it just starts to bottom out on top of lift nut¹. Tighten set screws.

IMPORTANT: In those cases where a limit nut is used to stop the upward gate travel, and a pedestal lift is also used, the limit nut must be installed on stem prior to installing lift.

¹ If gates have wedges that require adjustment, final setting and tightening of nut will have to be done after gate wedges are adjusted.

WATERMAN INDUSTRIES

FIELD PAINTING

The following procedures should be followed for field painting equipment supplied with primer only or for recoating installed equipment for continued maintenance and protection.

1. Before any sandblasting or painting, all seating and wedging surfaces should be properly protected by masking. Wedges should not be removed from gate.
2. The gate should not be disassembled unless absolutely necessary. The slide (disc) can be removed from the guides by removing shipping stops.
3. All machined surfaces not primed on gates and appurtenances (i.e. stem guide bushing, lift input shafts, gate flanges, etc.) should be properly protected by covering or masking.
4. Prepare all prime painted or previously painted surfaces in accordance with coating manufacturer's specification, prior to painting.
5. After painting, remove all masking and thoroughly clean all seating and wedging surfaces. Replace slides in gates if they have been removed. If gates are not installed, replace shipping stops.
6. Coat all machined sliding surfaces with grease of a type allowed by local or project specifications to be environmentally safe.

WATERMAN INDUSTRIES

INITIAL OPERATION OF GATES OR VALVES

1. After gate, stem guides, stem, lifting mechanism, and other necessary appurtenances have been installed, check the following prior to operation:
 - a. Check all assembly and mounting hardware for proper tightness.
 - b. Apply tension to stem and check for proper alignment.
 - c. Remove any shipping stops on gates.
 - d. Check gate guide grooves, seats, wedges for any foreign matter, and clean as necessary.
2. If not done previously or if gate stem has set some time after installation, thoroughly clean stem threads and lubricate in accordance with stem installation instruction.
3. Open gate slide to fully open position. All lifts are factory lubricated, so there is no need for additional lubrication.
 - a. For manually operated lifts, turn handwheel or handcrank in direction noted on handwheel or lift housing.
 - b. Electric operators should be initiated per instructions in the operation manual for this item.
 - c. Pressure must be applied to bottom side of cylinder pistons to get gate to rise. This should be done with manually actuated controls, rather than automatic controls, with pressure being applied very slowly and carefully¹.
4. Clean all dirt, paint, concrete splatter, or other foreign material from seating surfaces, wedges, flushbottom seal, etc.

¹ On pneumatic operators, gate will “jump” out of closed position then begin steady rising movement. There is no way to prevent this. Regardless of operator, operation should be easy and unlabored. If not, check for binding or other causes by reviewing previously mentioned installation and start-up procedures. Do not apply any excess force to handwheel or handcrank on operators.

WATERMAN INDUSTRIES

INITIAL OPERATION OF GATES - (CONTINUED)

5. Grease all seating and wedging surfaces with water-resistant grease as noted below:
 - a. For machined iron or bronze seating or wedging surfaces, grease with Intertol Grease Coating, as manufactured by Koppers, Inc., or equal.¹
 - b. Grease stainless steel seats and wedging surfaces with Never-Seez, manufactured by Never- Seez Corporation or equal.¹ For best results, mix Never-Seez with an equal portion of ten-weight oil.
 - c. Seating surfaces of aluminum or fiberglass slide gates, including gates with UHMW polyethylene bearing strips, require no lubrication.
6. Close gate completely and check for proper closure.
 - a. On all cast iron sliding gates (also applicable to flap gates and shear gates) check seat clearance with .004" feeler gauge. Best results can be obtained by checking seat faces from backside of gate when installation permits. Adjust any wedges as necessary per applicable wedge adjustment procedures following, until .004" feeler gauge cannot be inserted between seats.
 - b. On fabricated slide gates, check to see that slide fits flat against seating surface. Check to be sure frame is not warped.

CAUTION: Be extremely careful when closing gate so as not to apply excessive compressive force on stem. The stem under a compressive load is the weakest link in the system and can buckle (bow) if excessive force is applied to operator. Limit nuts should be in place if applicable.

7. Set any limit nuts or position indicators as required per applicable instructions.
8. Cycle gates with operators to ensure proper installation, alignment, and operation.

¹ See lubrication chart (page 6.10) for equivalent lubricants. NOTE: Some installations may require food grade lubricants due to environmental conditions. If so, use Huskey "Husk-It" Lube-O-Seal or equivalent.

FIELD LEAKAGE TEST PROCEDURE - WEIR GATES

1. Install weir gates per instructions in this manual.
2. Check tightness of rubber seals behind gate slide with a .002" feeler gauge. The gauge should not pass between the seal and the slide at any point. If necessary, adjust per instructions on page 5.1 of this manual.
3. Ensure gate is clean and free of all debris.
4. Lubricate stem threads and operator prior to operation.

NOTE: Operators are lubricated at the factory but may require additional lubrication if they have been stored more than six (6) months.

5. Gate should be fully raised (closed) to begin test. Fill structure with water to within 1/8" of weir gate crest. Measure leakage by collecting water in trough or similar device for a period of one (1) minute. Leakage should not exceed 0.1 gallons for each linear foot of sealed perimeter.

Example: A 24 X 30 gate (24" wide X 30" tall) has a seal perimeter of 7ft. $(2.5 + 2.5 + 2)$ therefore the leakage should be no more than 0.7 gpm.

6. If leakage exceeds above parameters, locate point of most leakage, decrease water level to below gate invert, and tighten seal in vicinity of leak. Retest as necessary.
7. If, after tightening seals, proper water tightness is not reached, consult your nearest factory representative.
8. Cycle test gate if required by specifications.

WATERMAN INDUSTRIES

FIELD LEAKAGE TEST PROCEDURE - SLIDE GATES

1. Install gate(s) per installation instructions in this manual.
2. Check tightness of seals behind gate slide with a .002" feeler gauge. The gauge should not pass between the seals and the slide at any point. If it does, check the gate frame for warpage or bowing. If unable to locate a problem consult the factory.
3. Ensure gate is clean and free of all debris.
4. Lubricate stem threads prior to operation.

NOTE: Operators are factory lubricated but may require additional lubrication if stored for more than six months.

5. Gate should be fully closed to begin test. Fill structure with water to the normal operating depth. Measure leakage through the gate by collecting in a trough or similar device for a period of one (1) minute. Leakage **SHOULD NOT** exceed 0.1 gpm per foot of gate periphery.

Example: A 24 X 24 gate has 8 feet of periphery, allowed leakage would be 0.8 gpm.

6. If excessive leakage occurs, locate source of leak. Tighten seals if necessary or repair gate-to wall grout seal. Retest as necessary.
7. If unable to obtain satisfactory results, consult with the factory.
8. Cycle-test gate open and closed to ensure free operation.

WATERMAN INDUSTRIES

PROCEDURE FOR SETTING CLEAR PLASTIC STEM COVER INDICATORS

1. Indicators must be installed after lift and stem cover have been properly installed and gate adjusted for proper seating.
2. Thoroughly clean and dry plastic stem cover.
3. Graduated, self-adhesive Mylar tape has been supplied to provide gate open indication.
4. Mark plastic stem cover where top of stem meets with gate in OPEN (fully lowered) position.
5. Remove protective covering from adhesive and smoothly apply Mylar strip to plastic, being sure not to get any wrinkles or air bubbles under tape. Cut excess tape just under top cap and remove.
6. Thoroughly press and smooth tape against the plastic tube to ensure adhesion.

WATERMAN INDUSTRIES

SLIDE GATE TROUBLE SHOOTING GUIDE

The installation of slide gates requires a great deal of care to prevent damage to the gates and distortion of the frame. Slide gates are an economical choice for open channel flow applications where tight sealing is not necessary, and some leakage is to be expected. However, the following trouble-shooting tips may help to reduce the leakage and improve the performance of the gate.

SYMPTOM: *Leakage at bottom of gate.*

CAUSE:	REMEDY:
Concrete, asphalt, or debris under Q-seal on stop bar or in sill slot of a standard invert gate.	Remove foreign material. Check seal for permanent damage and possible replacement.

SYMPTOM: *Leakage at sides of gate.*

CAUSE:	REMEDY:
Concrete or debris wedged between disc and guide.	Remove foreign material.

SYMPTOM: *Leakage at sides or bottom of gate.*

CAUSE:	REMEDY:
Generally occurs on gates distorted by bolting to uneven concrete walls without the use of grout.	Loosen anchor bolt nuts, shim gate to true plane, and fill in void between guide and wall with grout.

SYMPTOM: *Leakage at top of gate.*

CAUSE:	REMEDY:
Excessive hoist effort at closed position deflecting the top of disc outward.	Limit hoist input to 40# pull. Set stop collar on stem as described on page 3.8.

SYMPTOM: *Leakage at invert of gate used as downward opening weir.*

CAUSE:	REMEDY:
“J” seal may be out of adjustment across invert.	Loosen seal retainer bolts and force seal out into contact with disc. Tighten bolts.

SYMPTOM: *Excessive effort to operate.*

CAUSE:	REMEDY:
Dry stem threads or grit-laden grease in threads.	Clean threads and grease with extreme pressure lubricant.

SYMPTOM: *Excessive effort to operate.*

CAUSE:	REMEDY:
May occur on long weirs with multi stem application pulling the disc unevenly.	Disconnect couplings in interconnecting shafts. Rotate individual hoist head pinion shafts until disc top is level then reassemble shaft couplings.

WATERMAN INDUSTRIES

ELECTRIC MOTOR OPERATOR TROUBLE SHOOTING GUIDE

If Geared Limit Switch Fails to Stop Valve Travel, check the following:

- a. Control wiring and motor reversing contact.
- b. Geared limit switch setting.
- c. Setting rod to see that it has been backed off after each side of switch has been set.
- d. Remove limit switch gearbox cover and inspect for damaged or broken gear teeth.

If Unable To Operate Unit by Motor:

- a. Check both motor power and control circuits for supply and continuity.
- b. Compare supply voltage with motor and controller nameplate rating, if fine, check motor amperage load.
- c. If stalled rotor is indicated, shut off power and operate unit by handwheel to move valve.

Excessive Handwheel Effort Can Indicate the Following:

- a. Improperly lubricated or damaged valve stem.
- b. Valve packing gland too tight.
- c. Improperly lubricated valve.
- d. Stem nut too tight on valve stem.
- e. Faulty or damaged valve or parts.

WATERMAN INDUSTRIES

MAINTENANCE OF GATES OR VALVES

Other than periodic cleaning as required to maintain smooth operation or painting to maintain appearance, no maintenance is required on the following listed equipment: Slide gates

NOTE: Gates may require occasional cycling to alleviate sticking. Cycling at minimum 30 day intervals is recommended.

WATERMAN INDUSTRIES

MAINTENANCE OF OPERATING STEMS

1. It is critical that operating stem be periodically cleaned and greased. Even though some environmental conditions are harsher than others and the use of pipe covers will protect stems, they still need to be cleaned and greased with Mobilux grease #2EP or equal¹ at least once every six (6) months. More often if the grease becomes dirty.

WARNING: Non-rising stem gates generally require a special maintenance program. If the level of the fluid rises above the top of the opening, the threads on the stem may become coated with grit. Under this condition, frequent use of the gate will wear the threads in the thrust nut creating a dangerous and possible damaging situation. Therefore the following maintenance procedure should be followed:

2. If practical, the stem should be kept clean and greased.
3. If the gate is cycled on the average of once a week, the thrust nut should be removed every year and inspected for wear. (More frequently after the first signs of wear or if the frequency of operation is greater or the conditions are severe.)

¹ See lubrication chart for equivalent lubricants. Page 6.10.

WATERMAN INDUSTRIES

MAINTENANCE OF MANUAL GATE OPERATORS

1. At least three (3) times a year, all grease fittings on manual floor stands should be lubricated with small amount of heavy-duty grease, such as Zenaplex II manufactured by Penwalt Keystone Company, or equal.¹

Handcrank or handwheel should be turning when grease is pumped into the fitting. Four (4) or five (5) pumps of the grease gun handle should be adequate each time the grease gun is used.

CAUTION: DO NOT OVERFILL when filling pinion shafts on manual 3EP series lifts.

2. For electric motor operated or cylinder lifts see separate manufacturers O & M manuals.

¹ See lubrication chart for equivalent lubricants. Page 6.10

WATERMAN INDUSTRIES

Suggested Inventory: 1-3 gallons
Delivery Times: 3 weeks
Shelf Life Limitations: 3 years
Store in a cool, dry place.

LUBRICATION CROSS REFERENCE CHART

STEMS: (Every 6 months)

LUBRICANT

Lubriplate SFL-1
Molykote Type G
Valvoline Wal-Lith #2EP
No. 52 Grease
Dura Lith #2
Lubriplate #630-2
Gulf Crown EP2
Mobilux Grease #2EP
Mobil Grease #4
Alvania #AEP
MultiFak #2EP
Tycol Azepro #11
Centaur XHP 221

MANUFACTURER

Fiske Bros. Refining Co
Alpha Molykote Co.
Ashland Oil & Refining Co.
Atlantic Richfield (ARCO)
Chevron Oil Co.
Fiske Bros. Refining Co.
Gulf Oil Co.
Mobil Oil Co.
Mobil Oil Co.
Shell Oil Co.
Texaco Oil Co.
Tidewater Oil Co.
Mobil Oil Co

LIFTS: (Every 3 Months) (also Aux. Gearboxes and Universal Couplings)

LUBRICANT

Generic: Molybdenum Auto Di-Sulfide Bearing Grease. NLGI2 EP Grease -30°F, +250°F
Lubriplate Type 630-AA
Mobilplex #45
Mobil Grease Special
Zenaplex II
Centaur XHP 221

MANUFACTURER

Fiske Brothers Refining Co.
Mobil Oil Co.
Mobil Oil Co.
Penwalt Keystone Co.
Mobil Oil Co

MACHINED IRON AND BRONZE SURFACES SEATS AND WEDGES: (As needed)

LUBRICANT

Lubriplate FGL-2

NO-OX-ID

Intertol Grease Coating
Centaur XHP 221

MANUFACTURER

Fiske Bros. Refining Co

W.R. Grace, Inc.
(Dearborn Chemical Division)
Koppers, Inc.
Mobil Oil Co

STAINLESS STEEL SURFACES (Seats and Wedges): (As needed)

Never-Seez
Centaur XHP 221

Never-Seez Corp.
Mobil Oil Co

WATERMAN INDUSTRIES, INC.

SPECIAL TOOLS

The installation and adjustments of **Waterman** gates and equipment requires no special tools and can be accomplished using a minimum of the following standard tools:

10" or 12" Crescent Wrench (2 required)

1/2" or 5/8" Allen Wrench

.004" Feeler Gauge

While these are the minimum tools required, installation time can be greatly decreased with such standard tools as socket wrenches and box wrenches.

If electric motor operated lifts, or cylinder operators are supplied, see separate manufacturer's Operation and Maintenance manual for special tools.

WATERMAN INDUSTRIES

SPARE PARTS & PARTS REPLACEMENT

All products supplied by **WATERMAN INDUSTRIES** are designed to last indefinitely if properly maintained and operated, therefore, no spare parts are recommended.

Should it become necessary to replace a part, refer to the enclosed installation or detail drawings for the appropriate parts number or size. Replacements may be ordered direct from the factory or through your local representative. Always be prepared to give the Waterman Job number and installation drawing number (see *Field Service*, Pg. 8.0).

If certain spare parts were required by project specifications, they will be listed on sheet 7.0.1, under *Spare Parts Addendum*.

Replacement parts for “vender supplied” products, i.e. motorized operators, hydraulic cylinders, etc. should be ordered as recommended in separate manufacturers O & M data located elsewhere in this manual.

WATERMAN INDUSTRIES, INC.

FIELD SERVICE

When trouble develops either in the installation, operation, or performance of the equipment, the installation manual and drawings should be checked to determine if the equipment has been installed properly. If proper performance and operation cannot be obtained, and assistance from the factory is desired, please contact the factory and **REFERENCE THE JOB NUMBER A19418L**, so that we may locate the project records and better assist you. Our company may be contacted at:

WATERMAN INDUSTRIES, INC
P.O. BOX 458
EXETER, CALIFORNIA 93221

PHONE: (559) 562-4000
FAX: (559) 562-2277

Arrangements may be made to send a representative to the jobsite if this is required. If the equipment is faulty in workmanship or material, the necessary repairs or adjustments will be made by the factory at no cost to the purchaser. If, however, the problem is due to faulty installation or adjustment, the cost of the field service will be charged to the purchaser.

If repairs are made in the field by the purchaser or authorized by the purchaser, back charges for these repairs will **NOT** be accepted by the company unless the company has been notified prior to the incurring of these costs and has accepted the responsibility for these repairs. **ANY UNAUTHORIZED REPAIRS OR CHANGES TO EQUIPMENT WILL AUTOMATICALLY VOID WARRANTY.**

The company will not be liable for contingent costs or costs of delay due to the faulty equipment and the repairs thereof.

FIELD SERVICE CHARGES

Field service charges begin from the time of departure until the return of the service man and include a daily rate plus travel and subsistence expenses. Premium day and hourly rates will be charged on Saturdays, Sundays and Holidays and for time spent before 6 a.m. or after 5 p.m. or over eight (8) hours per day. A schedule of Field Service charges can be obtained by calling Waterman Industries, Inc.

If service personnel are required for equipment produced by another manufacturer (i.e. for electric Motor operator), that manufacturer's standard service charges will prevail.

WATERMAN INDUSTRIES

LIMITED WARRANTY

Every effort is made to assure the highest quality merchandise, free of any defects. Merchandise is warranted against defects in material and workmanship when used in accordance with the standards and/or instructions recommended by this catalog or other written quotation of this firm. No warranty, expressed or implied, is made other than as follows:

Products manufactured by **WATERMAN INDUSTRIES** are warranted against defects in materials and workmanship for twelve (12) months after substantial completion or acceptance - such warranty can only be enforced by the original consumer purchaser.

During the warranty period, the product will be repaired or replaced at **WATERMAN INDUSTRIES** option with no cost to the purchaser.

Measure of damage is the price of defective material only. No charges for labor or expense required to remove or to replace defective material or for any consequential damages will be allowed. Warranty excludes damage due to misuse, neglect or misapplication.

Any implied warranty of merchantability of fitness is limited to the duration of this written warranty. To the extent allowed by law, neither **WATERMAN INDUSTRIES** nor its selling dealer or agent shall have any responsibility for loss of use of the product, loss of time, commercial loss or consequential damages.

In the event a warranted product is believed defective, notify your Waterman Sales Office and furnish date purchased, copy of invoice or shipping documents. **DO NOT** attempt repairs or returns without authorization from **WATERMAN INDUSTRIES**. Unauthorized repairs may void warranty, and costs for unauthorized repairs performed or replacement parts purchased within the warranty period will not be reimbursed. A return authorization number must be obtained from **WATERMAN INDUSTRIES** prior to returning any merchandise.

Some states do not allow limitations on how long an implied warranty lasts or the exclusion or limitation of consequential damages, therefore the above limitation may not apply.

This warranty gives you specific legal rights. You may also have other rights, which may vary from state to state.

It is the policy of this company to encourage the settlement of disputes in an informal manner. If such disputes arise over a warranty claim an informal dispute settlement mechanism can be agreed upon at that time.

WATERMAN INDUSTRIES, INC.

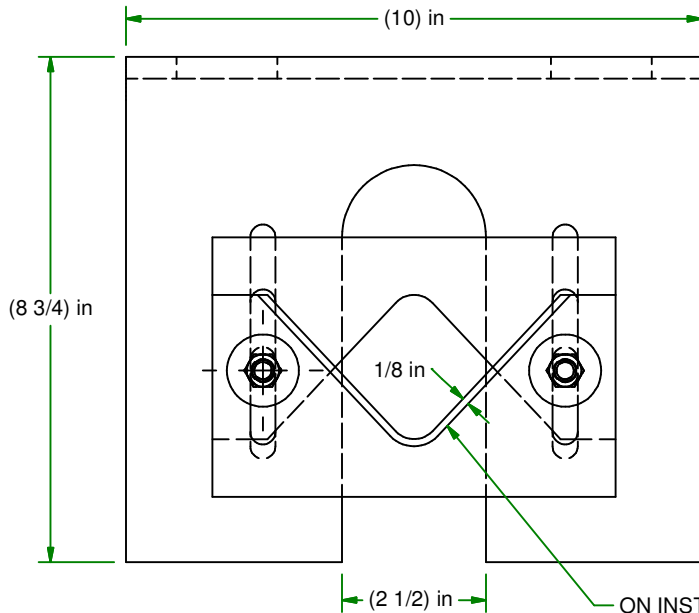
EMERGENCY OPERATING INSTRUCTIONS

1. Manual gate operators have no emergency procedure.
2. Electric motor operators may be operated manually in the occurrence of an electrical failure by moving the handwheel clutch lever arm in the direction indicated on the operator housing. Rotating the handwheel will move the gate open or closed. The handwheel clutch will automatically disengage when unit is operated electrically.

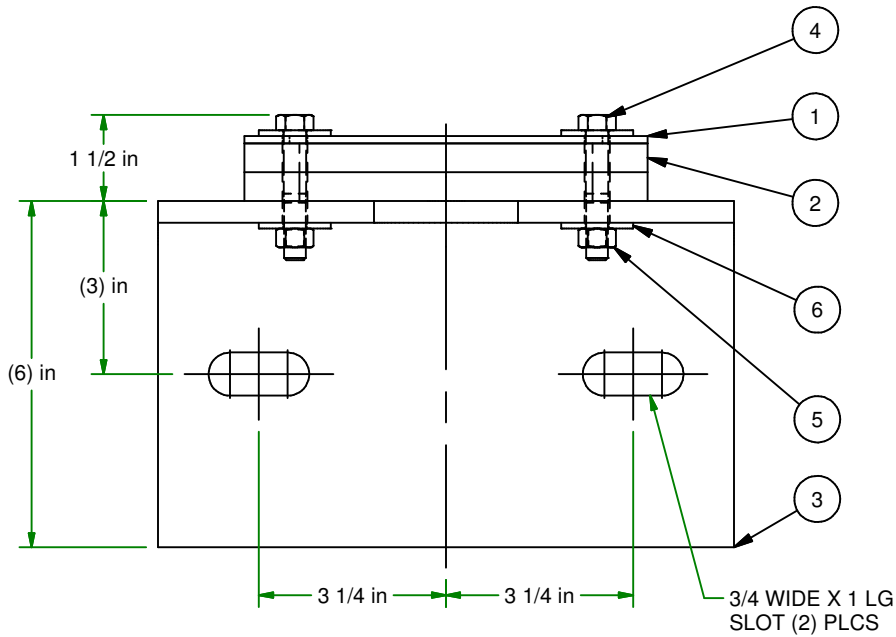
SAFETY INSTRUCTIONS

1. Sluice and Slide Gates
 - a. **DO NOT** apply water pressure above the gate capacity listed on the engineering drawings.
 - b. Keep hands, clothing, tools, etc. Away from moving gate.
 - c. Do not work or loiter beneath an open gate leaf without providing stop blocks and removing electrical power from electrical operated gates.
2. Electric Motor Operators
 - a. See operator instruction manual for manufacturer safety instructions.
 - b. Operator electrical cabinet contains **HIGH VOLTAGE**. Do not attempt adjustment or repair unless qualified. Disconnect power before opening.
3. Flap Gates
 - a. **DO NOT** apply water pressure above the gate capacity listed on the engineering drawings.
 - b. Keep hands, clothing, tools, etc. away from moving gate.
4. Telescoping Valves
 - a. Keep hands, clothing, tools, etc. away from moving valve.

REVISION HISTORY			
REV	DESCRIPTION	DATE	APPROVED
-	Drawing created	10/14/10	JMSpeidel



ON INSTALLATION ALIGN PLATE SO STEM DOES NOT RUB GUIDE PLATE



- 3. SPLIT DESIGN TO ALLOW INSTALLATION OF GUIDE AFTER STEM INSTALLED
- [2] FOR MATERIAL TYPE SEE SUBMITTAL DRAWING
- 1. STEM RANGE $\varnothing 7/8$ INCH - $\varnothing 2$ INCH STEM

NOTES: UNLESS OTHERWISE SPECIFIED [UOS]

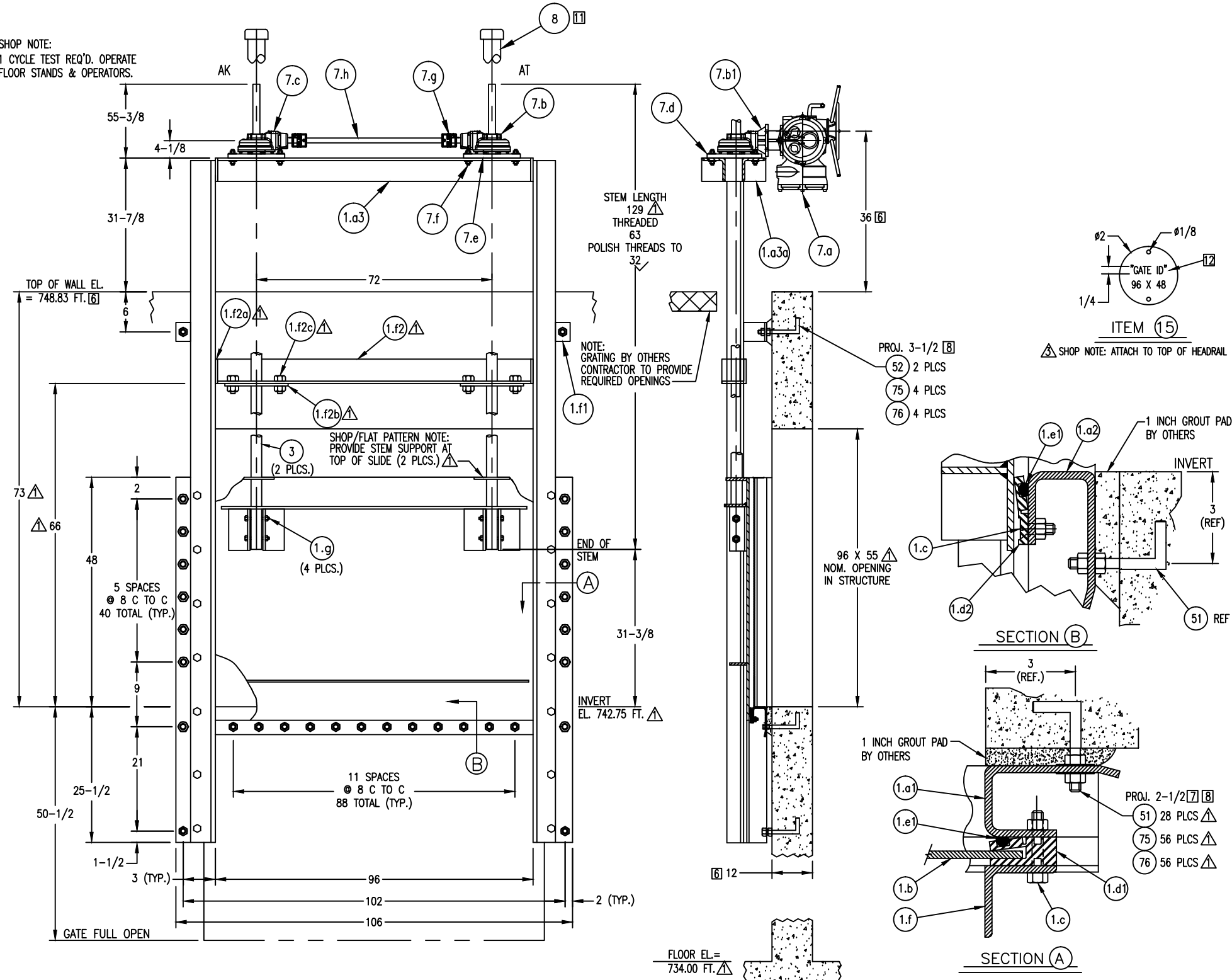
Parts List			
ITEM	QTY	PART NUMBER	DESCRIPTION
1) Support Plate	1	106918	Stainless Steel [2]
2) Guide Plate	2	106919	UHMW Polyethylene
3) Support Bracket	1	109954	Stainless Steel [2]
4) Hex HD Bolt	2	3/8-16 UNC - 2 1/2 LG	Stainless Steel [2]
5) Nut	2	3/8	Stainless Steel [2]
6) Washer	4	3/8	Stainless Steel [2]

DIMENSIONS AND TOLERANCES PER ANSI Y-14.5-1994				 EXETER, CALIFORNIA 93221	
.XX ± 0.03	.XXX ± 0.010	ANGLES ± 1/2'	BREAK ALL SHARP EDGES		
MACHINE SURFACES 125 ✓ OR BETTER		NEXT ASSY	USED ON	SIZE A	DRAWING NUMBER 106920
DIMENSIONS IN INCHES	SCALE: N.T.S.	DRAWN	Jose.Lara 7/7/2010		
UNLESS OTHERWISE SPECIFIED [UOS]		CHECKED	Lou Berberian	WT: N/A	SHEET 1 of 1

DIMENSIONS FOR CAST IN PLACE J-HOOK ANCHORS	
NOMINAL DIAMETER	EMBEDDED DEPTH
1/2	6-1/2

NOTE: HANDRAIL (BY OTHERS) NOT SHOWN. CONTRACTOR TO ENSURE CLEARANCE FOR HANDCRANK OPERATION. [6]

SHOP NOTE:
1 CYCLE TEST REQ'D. OPERATE FLOOR STANDS & OPERATORS.



STEM LENGTH
129
THREADED
63
POLISH THREADS TO
32

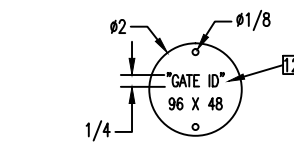
NOTE: GRATING BY OTHERS CONTRACTOR TO PROVIDE REQUIRED OPENINGS

SHOP/FLAT PATTERN NOTE:
PROVIDE STEM SUPPORT AT TOP OF SLIDE (2 PLCS.)

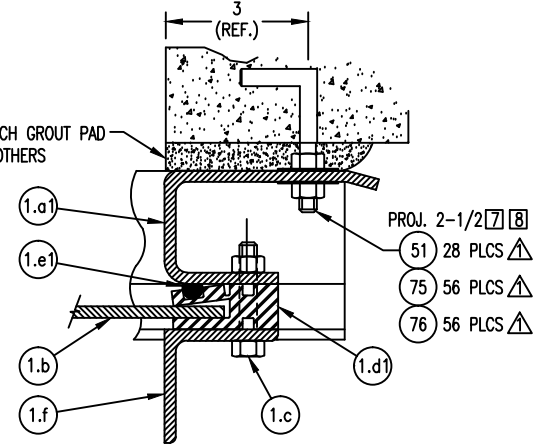
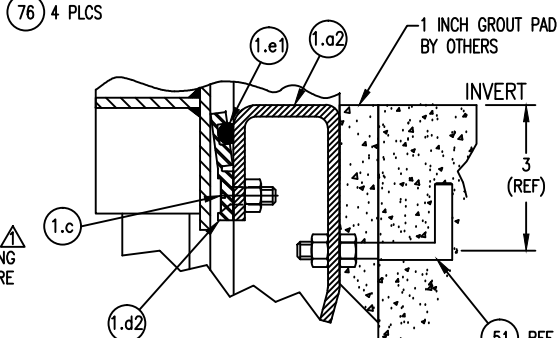
END OF STEM

INVERT EL. 742.75 FT.

FLOOR EL. = 734.00 FT.



SHOP NOTE: ATTACH TO TOP OF HEADRAIL



MATERIAL KEY	FINISH KEY	PAINT KEY
1. CAST IRON:ASTM A-126 CL. B 4. MANGANESE BRONZE: ASTM B-584 ALLOY 865 9B. STN STL SHAPES:ASTM A-276 TY.316/316L D/C 9D. STN STL PLATE:ASTM A-240 TY.316/316L D/C 13. NEOPRENE RUBBER:ASTM D-2000 14. CLEAR PLASTIC BUTYRATE PIPE:ASTM D-707 15B. STN STL HDW:ASTM F-593G/H & 594 GRP 2 (TY 316) 15D. STN. STL. HDW: ASTM F-879 GRP 1 (TYP 316) 21. UHMW POLYETHYLENE:ASTM D-6712 35A. PVC PLASTIC:ASTM D-1785	1. AS CAST 2. MILL 3. MACHINED 4. GALVANIZE-ASTM A-123 5. GALVANIZE-ASTM A-153 6. SEE PAINT KEY	6E-1 BLAST CLEAN PER SSPC-SP10 (1) CT (4-6 MILS) TNEPEC SERIES V69 (2) CTS (4-6 MILS/CT) TNEPEC SERIES V69 POLYAMIDE EPOXY (TDFT-12 MILS) COLOR: GRAY [6] 6H-3 BLAST CLEAN PER SSPC-SP6 (2) CTS (4-6 MILS/CT) TNEPEC SERIES V69 POLYAMIDE EPOXY & (1) CT (3 MILS) CARBOTHANE 134 POLYURETHANE ENAMEL (TDFT-12 MILS) COLOR: GRAY [6] 6T ROTORK STANDARD SHOPCOAT

ITEM DESCRIPTION	MATERIAL KEY	FINISH KEY	PART NO. OR SIZE (FOR WATERMAN USE ONLY)	QTY/ GATE	TOTAL QTY
1. GATE ASSEMBLY	-	-	REF. 108497	1	6
a) FRAME WELDMENT	9D	2	REF. 108498	1	
1) GUIDE RAIL	9D	2	REF. 108312	2	
2) CROSS RAIL	9D	2	REF. 108310	1	
3) HEADRAIL	9D	2	6 X 3 X 1/4 ANGLE (SEE BUILD PLANS)	2	
a) HEADRAIL ENDPLATE	9D	2	1/4 THK. (SEE BUILD PLANS)	2	
b) COVER WELDMENT	9D	2	SEE BUILD PLANS	1	
c) ASSEMBLY HARDWARE	15B,15D	2	3/8 NC	A/R	
d) SEATS & SPACER	-	-	-	-	
1) SIDE SEAT	21	2	REF. 107595/108391	2	
2) CROSS SEAT	21	2	-	1	
e) SEALS	-	-	-	-	
1) SEAL	13	2	REF. 109352-21	A/R	
f) RETAINER ANGLE	9D	2	3 X 3 X 1/4 ANGLE	2	
1) ANCHOR TAB	9D	2	3 X 3 X 1/4 ANGLE X 2 LG.	2	
2) STEM BRACE (BOLT ON)	9D	2	REF. 109348 MOD. FOR TANDEM	1	
a) STEM BRACE END PLATE	9D	2	1/4 THK. (REF. 109348)	2	
b) STEM GUIDE & RETAINER PLATE	9D,21	2	REF. 108161 & 108160	2/2	
c) HEX HEAD BOLT, NUT, & WASHER	15B	2	1/2 NC x 1-1/2 LG.	4/4/8	
d) STEM BOLT & NUT	15B	2	5/8 NC x 3 LG.	4/4	
3. STEM	9B	2,3	1-1/2 DIA., 4 TPI, [5] [10] (REF. 106219)	2	12
7. LIFT ASSEMBLY	-	-	-	1	6
a) ELECTRIC MOTOR OPERATOR	1,4	6T	ROTORK MODEL IQ25FA14B4	1	
b) LIFT (DRIVE)	1,4	6H-3	3R4-2:1 TRIPLE BOSS @ 90° (SYTLINE # 48895396)	1	
1) INPUT FLANGE	-	6H-3	SYTLINE # 40705450	1	
c) LIFT (SLAVE)	1,4	6H-3	TYPE 3R4-2:1 (REF. 110190)	1	
d) BASEPLATE	1	6H-3	REF. 109934	2	
e) FLAT HEAD BOLT	15D	2	3/8 NC X 1-3/4 LG.	8	
f) HEX HEAD BOLT, NUT & WASHER	15B	2	1/2 NC X 2-1/2 LG.	8/8/16	
g) COUPLING	-	-	LOVEJOY L095 (SYTLINE NUMBER 2961100)	2	
h) INTERCONNECTING SHAFT	9B	2,3	1 INCH DIA. (REF. 105283)	1	
i) KEY (NOT SHOWN)	-	-	1/4 X 1/4 X 1 LG.	2	
8. STEM COVER (W/ MYLAR STRIP) [11]	14.35A	2	REF. 110257 (3 X 2-1/2 IN) 54 LG.	2	12
15. ID TAG	9D [13]	2	12 GA. (SEE DETAIL THIS SHEET)	1	6
51. THREADED STUD (J-TYPE)	9B	2,3	1/2 NC X 9 LG.	28	168
52. THREADED STUD (J-TYPE)	9B	2,3	1/2 NC X 10 LG.	2	12
75. HEX NUT	15B	2	1/2 NC	56	336
76. WASHER	316 STN. STL.	2	1/2 DIA.	56	336

NOTES: UNLESS OTHERWISE SPECIFIED.
 1. (GATE CAPACITY) MAXIMUM SEATING HEAD = 3 FT.; MAXIMUM UNSEATING HEAD = 3 FT. (S.P. = 104 LB/IN)
 2. OPERATING HEAD FROM GATE CENTER LINE: SEATING HEAD = 3 FT.; UNSEATING HEAD = 3 FT. [6]
 3. LIFT CAPACITY = 3,171 LBS. @ 10.75 IN/MIN (43 RPM); TORQUE 39 FT-LBS.
 4. TURN HANDWHEEL CCW TO OPEN (LOWER) GATE.
 [5] 29" STUB ACME THREADS.
 [6] CONTRACTOR TO VERIFY OR SUPPLY.
 [7] DIMENSION INCLUDES 1 INCH FOR GROUT PAD.
 [10] PROVIDE RH THREAD FOR AT LIFT & LH THREAD FOR AK LIFT.
 [11] TO BE MARKED WITH 1/4, 1/2, 3/4, & FULL OPEN POSITIONS.
 [12] GATE ID: F-60-1, F-60-2, F-60-3, F-60-4, F-50-1, & F-50-2.
 [13] SHOP NOTE: PER CUSTOMER SPECIFICATION.
 (4) GATES REQUIRED AT EAST WEIR GATES (F-60-1 THRU F-60-4) [6]
 (2) GATES REQUIRED AT WEST WEIR GATES (F-50-1 THRU F-50-2) [6]



96 X 48 WATERMAN MODEL
SS-254-1-Y
SLIDE GATE

FOR: WALSH CONSTRUCTION II, LLC
3011 W. GRAND BLVD., SUITE 2300
DETROIT, MI 48202
PO: 212061P05
REF: ANN ARBOR WWTP
ANN ARBOR, MI

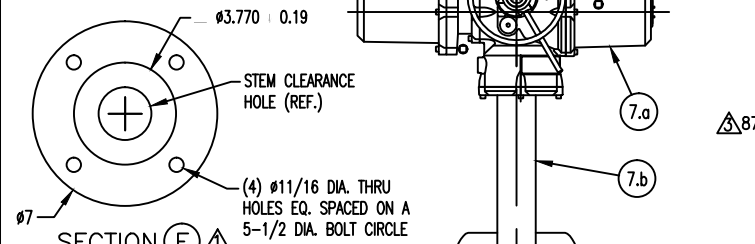
ENG: MALCOM PIRNIE

REV. NO.	DATE	BY	JOB NO.	PROJECT MANAGER		
			A19418L	DANNY WHITE		
REV. NO.	DATE	BY	QUOTE NO.	DRAWN BY	CHK'D BY	ENGINEER
			WQ12-A-19418	CL	DP/REM	REM
REV. NO.	DATE	BY	QUOTE ITEM NO.	SHEET		
[3]	OCT. 25, '13	CL	8	1 OF 1		
REV. NO.	DATE	BY	SCALE	DATE		
[3]	AUG. 7, '13	CL	NTS	NOV. 9, '12		
REV. NO.	DATE	BY	DRAWING NO.			
[3]	MAY 9, '13	CL	RB-12-0411			

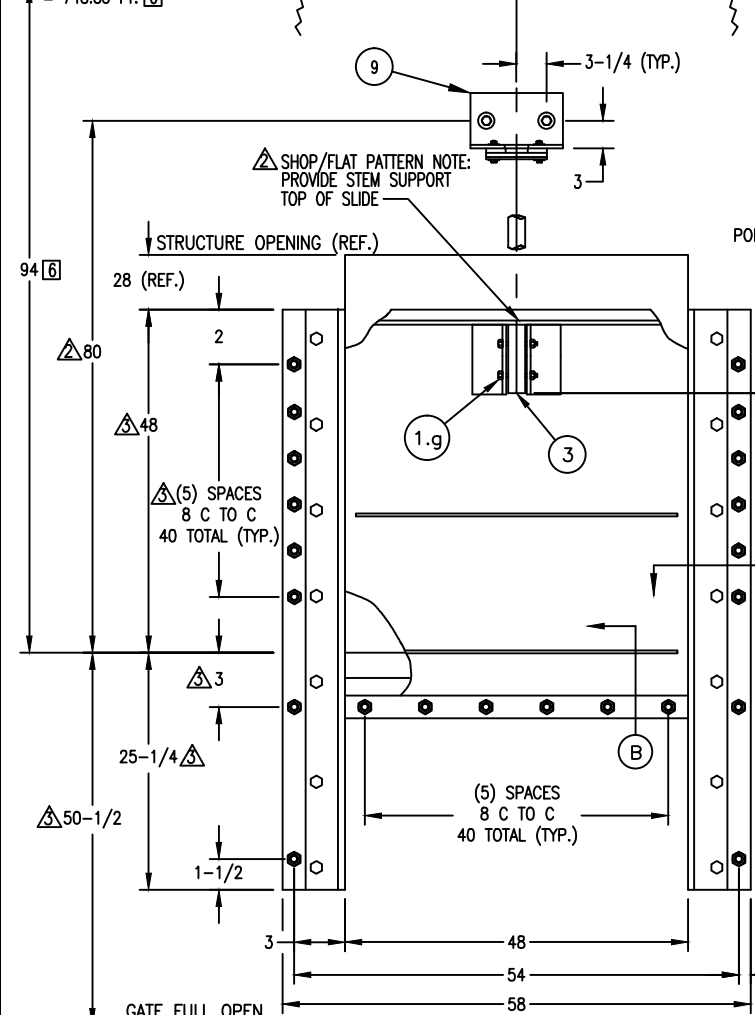
DIMENSIONS FOR CAST IN PLACE J-HOOK ANCHORS	
NOMINAL DIAMETER	EMBEDDED DEPTH
1/2	6-1/2
5/8	7-1/2
3/4	9

SHOP NOTE:
WELDERS CERTIFIED TO AWS D1.6.

SHOP NOTE:
1 CYCLE TEST REQ'D. OPERATE FLOOR STANDS & OPERATORS.



TOP OF WALL EL. = 748.83 FT. [6]



STEM LENGTH 145-1/2
THREADED LENGTH 63
POLISH STEM THREADS TO 32

INVERT EL. = 741.00 FT. [6]

ITEM (15)
SHOP NOTE: ATTACH TO PEDESTAL BASE [6]

FLOOR EL. [6] = 734.00 FT.

48 X 48 WATERMAN MODEL
SS-254-1
SLIDE GATE

FOR: WALSH CONSTRUCTION II, LLC
3011 W. GRAND BLVD., SUITE 2300
DETROIT, MI 48202

PO: 212061P05
REF: ANN ARBOR WWTP
ANN ARBOR, MI

ENG: MALCOM PIRNIE



P.O. BOX 458 • 25500 Road 204 • Exeter, California 93221 • Phone (559)562-4000 • FAX (559)562-2277 • www.watermanusa.com

REUSE OF DOCUMENTS: THIS DOCUMENT AND THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, IS THE INTELLECTUAL PROPERTY OF WATERMAN INDUSTRIES AND IS TO BE CONSIDERED CONFIDENTIAL AND PROPRIETARY. IT, OR THE IDEAS AND CONCEPTS DESCRIBED THEREIN, ARE NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER USE WITHOUT THE WRITTEN AUTHORIZATION OF WATERMAN INDUSTRIES.

MATERIAL KEY

- CAST IRON: ASTM A-126 CL. B
- MILL
- STRUCTURAL STEEL: ASTM A-36
- STN STL SHAPES: ASTM A-276 TY. 316/316L D/C
- STN STL PLATE: ASTM A-240 TY. 316/316L D/C
- STL PIPE: ASTM A-53 TY. E GR. A
- NEOPRENE RUBBER: ASTM D-2000
- CLEAR PLASTIC BUTYRATE PIPE: ASTM D-707
- STN STL HDW: ASTM F-593G/H & 594 GRP 2 (TY 316)
- STN. STL. HDW: ASTM F-879 GRP 1 (TYP 316)
- UHMW POLYETHYLENE: ASTM D-6712
- PVC PLASTIC: ASTM D-1785

FINISH KEY

- AS CAST
- MILL
- MACHINED
- GALVANIZE-ASTM A-123
- GALVANIZE-ASTM A-153
- SEE PAINT KEY

PAINT KEY

- 6E-2 BLAST CLEAN PER SSPC-SP10
(1) CT (4-6 MILS) TNE MEC V69
(2) CTS (4-6 MILS/CT) TNE MEC SERIES V69
POLYAMIDE EPOXY (TDFT-12 MILS)
COLOR: GRAY [6]
- 6H-3 BLAST CLEAN PER SSPC-SP6
(2) CTS (4-6 MILS/CT) TNE MEC SERIES V69
POLYAMIDE EPOXY & (1) CT (3 MILS)
CARBOATHANE 134 POLYURETHANE
ENAMEL (TDFT-12 MILS) COLOR: GRAY [6]
- 6T ROTORK STANDARD SHOPCOAT

ITEM DESCRIPTION	MATERIAL KEY	FINISH KEY	PART NO. OR SIZE (FOR WATERMAN USE ONLY)	QTY/	TOTAL QTY
1. GATE ASSEMBLY	-	-	REF. 108496	1	2
a) FRAME WELDMENT	9D	2	REF. 108499	1	
1) GUIDE RAIL	9D	2	REF. 108312	2	
2) CROSS RAIL	9D	2	REF. 108310	1	
b) COVER WELDMENT	9D	2	SEE BUILD PLANS		
c) ASSEMBLY HARDWARE	15B/15D	2	3/8 NC	A/R	
d) SEATS & SPACER	-	-	-	-	-
1) SIDE SEAT	21	2	REF. 107595/108391	2	
2) CROSS SEAT	21	2	REF. 107596/108392	1	
e) SEALS	-	-	-	-	-
1) SEAL	13	2	REF. 109352-21	A/R	
f) RETAINER ASSEMBLY	-	-	REF. 108501	1	
1) RETAINER ANGLE	9D	2	3 X 3 X 1/4 ANGLE	2	
g) STEM BOLT & NUT	15B	2	5/8 NC X 3 LG.	2/2	
3. STEM	9B	2,3	1-1/2 DIA., 4 TPI, RH [5] (REF. 106219-2)	1	2
7. LIFT ASSEMBLY	-	-	-	1	2
a) LIFT	1,4	6T	ROTORK MODEL IQ12 W/IB5-3:1	1	
b) PEDESTAL	6,11	6H-3	SEE BUILD PLANS	1	
c) HEX HEAD BOLT & WASHER	15B	2	5/8 NC X 1-3/4 LG.	4/4	
8. STEM COVER (W/ MYLAR STRIP) [10]	14,35A	2	REF. 110257 (3 X 2-1/2 IN) 54 LG.	1	2
9. STEM GUIDE	9D,21	2,3	TYPE K-2A (REF. 110258-1)	1	2
15. ID TAG	9D [12]	2	12 GA. (SEE DETAIL THIS SHEET)	1	2
51. THREADED STUD (J-TYPE)	9B	2,3	1/2 NC X 9 LG.	22	44
52. THREADED STUD (J-TYPE)	9B	2,3	5/8 NC X 9 LG.	2	4
53. THREADED STUD (J-TYPE)	9B	2,3	3/4 NC X 12-1/2 LG.	6	12
75. HEX NUT	15B	2	1/2 NC	44	88
76. WASHER	316 STN. STL.	2	1/2 DIA.	44	88
77. HEX NUT	15B	2	5/8 NC	2	4
78. WASHER	316 STN. STL.	2	5/8 DIA.	2	4
79. HEX NUT	15B	2	3/4 NC	12	24
80. WASHER	316 STN. STL.	2	3/4 DIA.	12	24

NOTES: UNLESS OTHERWISE SPECIFIED.

- (GATE CAPACITY) MAXIMUM SEATING HEAD = 4 FT.; MAXIMUM UNSEATING HEAD = 4 FT. (S.P. = 57 LB/IN)
- OPERATING HEAD FROM GATE CENTER LINE: SEATING HEAD = 4 FT.; UNSEATING HEAD = 4 FT. [6]
- LIFT CAPACITY = 3,740 LBS. @ 9.5 IN/MIN (38 RPM); TORQUE = 46 FT-LBS
- TURN HANDCRANK CCW TO OPEN (LOWER) GATE.
- 29" STUB ACME THREADS.
- CONTRACTOR TO VERIFY OR SUPPLY.
- DIMENSION INCLUDES GROUT PAD THICKNESS.

[9] GATE ID: (1) @ F-50-3 & (1) @ F-50-4.
[10] TO BE MARKED WITH 1/4, 1/2, 3/4, & FULL OPEN POSITIONS.

[12] SHOP NOTE: PER CUSTOMER SPECIFICATION.

(2) GATES REQUIRED @ INFLUENT SPLITTER/FLOW MONITORING AND CONTROL STATION [6]

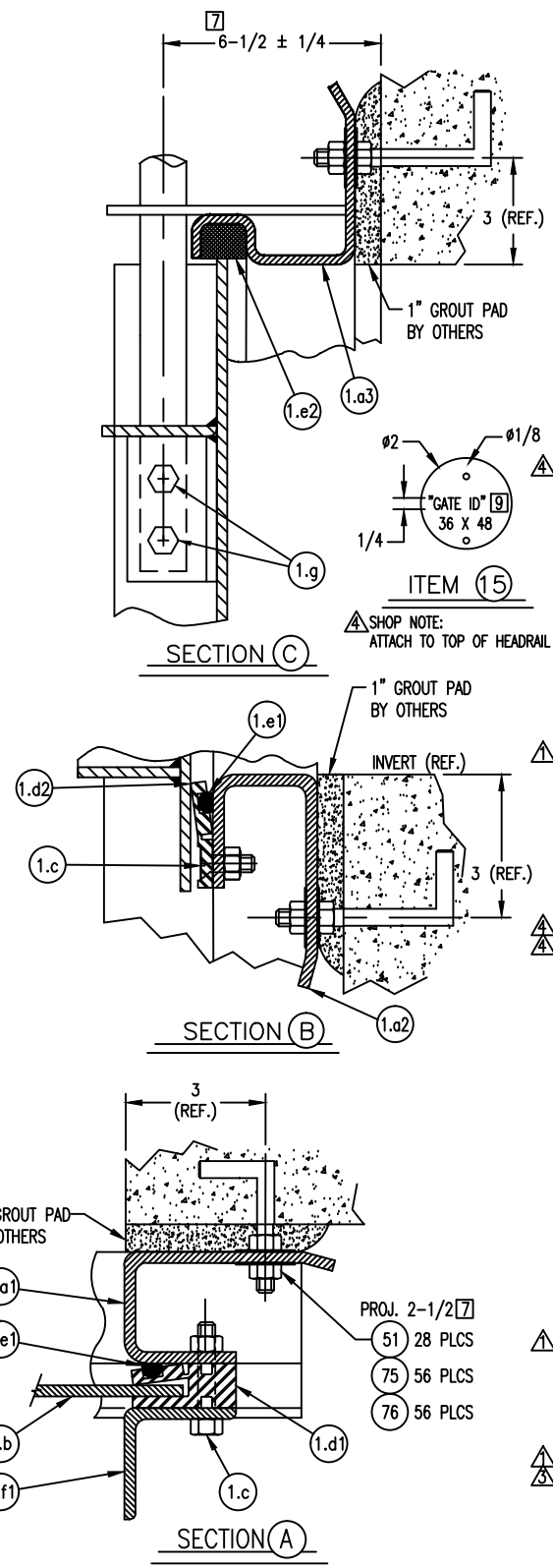
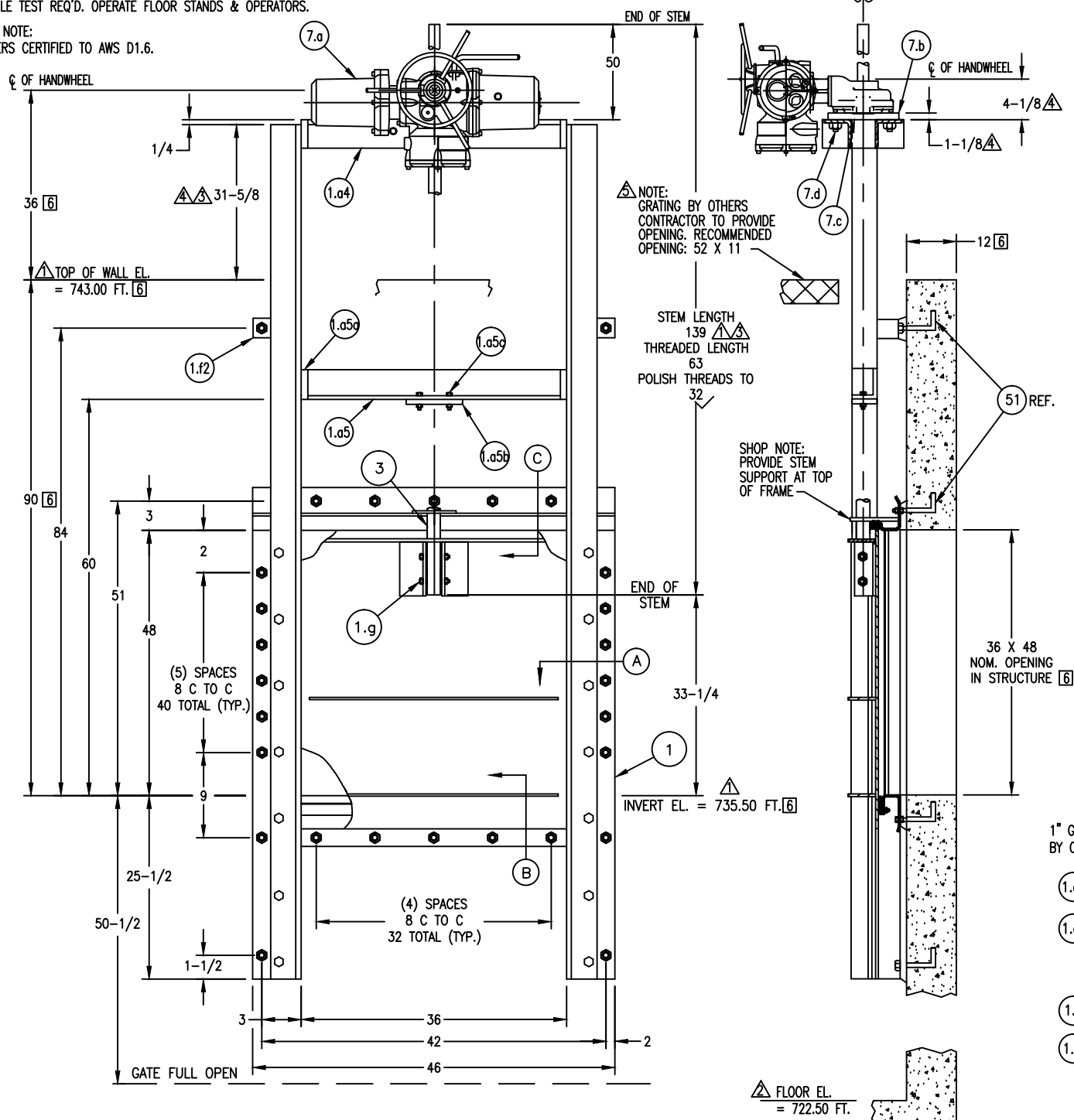
[6] PLAN REF. SHEETS: M03-01, M03-02, S03-02, & GATE SCHEDULE.

REV. NO.	DATE	BY	JOB NO.	PROJECT MANAGER
[12]	(AS BUILT) AUG. 8, '13 CL	RJ	A19418L	DANNY WHITE
[12]	(CUST. REV.) AUG. 7, '13 CL	DW	WQ12-A-19418	CL DP/REM REM
[12]	(RE-DRAWN) MAY 24, '13 CL	DW	9	1 OF 1
[12]	(RE-DRAWN) MAY 9, '13 CL	DW	NTS	NOV. 9, '12
[12]	(CUST. REV.) MARCH 1, '13 CL	DW	RB-12-0412	

DIMENSIONS FOR CAST IN PLACE J-HOOK ANCHORS	
NOMINAL DIAMETER	EMBEDDED DEPTH
1/2	6-1/2

CONTRACTOR NOTE:
FUNCTIONAL & LEAKAGE TESTS REQ'D.

SHOP NOTE:
1 CYCLE TEST REQ'D. OPERATE FLOOR STANDS & OPERATORS.
SHOP NOTE:
WELDERS CERTIFIED TO AWS D1.6.



MATERIAL KEY	FINISH KEY	PAINT KEY
1. CAST IRON:ASTM A-126 CL. B 4. MANGANESE BRONZE: ASTM B-584 ALLOY 865 9B. STN STL SHAPES:ASTM A-276 TY.316/316L D/C 9D. STN STL PLATE:ASTM A-240 TY.316/316L D/C 13. NEOPRENE RUBBER:ASTM D-2000 14. CLEAR PLASTIC BUTYRATE PIPE:ASTM D-707 15B. STN STL HDW:ASTM F-593G/H & 594 GRP 2 (TY 316) 15D. STN. STL. HDW: ASTM F-879 GRP 1 (TYP 316) 21. UHMW POLYETHYLENE:ASTM D-6712 35A. PVC PLASTIC:ASTM D-1785	1. AS CAST 2. MILL 3. MACHINED 4. GALVANIZE-ASTM A-123 5. GALVANIZE-ASTM A-153 6. SEE PAINT KEY	6E-2 BLAST CLEAN PER SSPC-SP10 (1) CT (4-6 MILS) TNEC SERIES V69 (2) CTS (4-6 MILS/CT) TNEC SERIES V69 POLYAMIDE EPOXY (TDFT-12 MILS) COLOR: GRAY [6] 6H-3 BLAST CLEAN PER SSPC-SP6 (2) CTS (4-6 MILS/CT) TNEC SERIES V69 POLYAMIDE EPOXY & (1) CT (3 MILS) CARBOTHANE 134 POLYURETHANE ENAMEL (TDFT-12 MILS) COLOR: GRAY [6] 6T ROTORK STANDARD SHOPCOAT

ITEM DESCRIPTION	MATERIAL KEY	FINISH KEY	PART NO. OR SIZE (FOR WATERMAN USE ONLY)	QTY/ GATE	TOTAL QTY
1. GATE ASSEMBLY	-	-	REF. 108496	1	4
a) FRAME WELDMENT	9D	2	REF. 108499	1	1
1) GUIDE RAIL	9D	2	REF. 108312	2	2
2) CROSS RAIL	9D	2	REF. 108310	1	1
3) FLUSH RAIL	9D	2	REF. 110160	1	1
4) HEAD RAIL	9D	2	4 X 4 X 1/4 ANGLE (REF. 107908 - MOD)	2	2
a) HEAD RAIL END PLATE	9D	2	1/4 THK. (REF. 107908 - MOD)	2	2
5) STEM BRACE	9D	2	REF. 109333 (MOD. G1 = 0)	1	1
a) STEM BRACE END PLATE	9D	2	1/4 THK. (REF. 109333)	2	2
b) STEM GUIDE RETAINER PLATE	21	2	REF. 105437	1	1
c) HEX HEAD BOLT, NUT, & WASHER	15B	2	1/2 NC X 1-1/2 LG.	2/2/4	2/2/4
b) COVER WELDMENT	9D	2	SEE BUILD PLANS	A/R	A/R
c) ASSEMBLY HARDWARE	15B/15D	2	3/8 NC	1	1
d) SEATS & SPACER	-	-	-	-	-
1) SIDE SEAT	21	2	REF. 107595/108391	2	2
2) CROSS SEAT	21	2	REF. 107596/108392	1	1
e) SEALS	-	-	-	-	-
1) SEAL	13	2	REF. 109352-21	A/R	A/R
2) FLUSH SEAL	13	2	REF. 110024	1	1
f) RETAINER ASSEMBLY	-	-	REF. 108501	-	-
1) RETAINER ANGLE	9D	2	3 X 3 X 1/4 ANGLE	2	2
2) ANCHOR TAB	9D	2	3 X 3 X 1/4 ANGLE	2	2
g) STEM BOLT & NUT	15B	2	5/8 NC X 3 LG.	2/2	2/2
3. STEM	9B	2,3	1-1/2 DIA., 4 TPI, RH [5] (REF. 106219-2)	1	4
7. LIFT ASSEMBLY	-	-	-	1	4
a) LIFT	1,4	6T	ROTORK MODEL IQ12 W/IB4-2:1 (REF. 107058)	1	1
b) BASEPLATE	1	6H-3	REF. 109934	1	1
c) FLAT HEAD BOLT & WASHER	15D	2	3/8 NC X 2 LG.	4/4	4/4
d) HEX HEAD BOLT, NUT, & WASHER	15B	2	1/2 NC X 1-1/2 LG.	4/4/8	4/4/8
8. STEM COVER (W/ MYLAR STRIP) [11]	14,35A	2	REF. 110257 (3 X 2-1/2 IN) 54 LG.	1	4
15. ID TAG	9D [12]	2	12 GA.	1	4
51. THREADED STUD (J-TYPE)	9B	2,3	1/2 NC X 9 LG.	28	112
75. HEX NUT	15B	2	1/2 NC	56	224
76. WASHER	316 STN. STL.	2	1/2 DIA.	56	224

NOTES: UNLESS OTHERWISE SPECIFIED.
1. (GATE CAPACITY) MAXIMUM SEATING HEAD = 4 FT.; MAXIMUM UNSEATING HEAD = 4 FT. (S.P. = 47 LB/IN)
2. OPERATING HEAD FROM GATE CENTER LINE: SEATING HEAD = 4 FT.; UNSEATING HEAD = 4 FT. [6]
3. LIFT CAPACITY 2,927 LBS. @ 10.75 IN/MIN (43 RPM); TORQUE = 36 FT-LBS
4. TURN HANDCRANK CCW TO OPEN (LOWER) GATE.
[5] 29" STUB ACME THREADS.
[6] CONTRACTOR TO VERIFY OR SUPPLY.
[7] DIMENSION INCLUDES 1 INCH FOR GROUT PAD.
[9] GATE ID: F-54-1, F-54-2, F-54-4, & F-54-5 [6]
[10] TO BE MARKED WITH 1/4, 1/2, 3/4 & FULL OPEN POSITIONS.
[12] SHOP NOTE: PER CUSTOMER SPECIFICATIONS.
(4) GATES REQUIRED @ AT-W1 & AT-W2 ANOXIC ZONE INFLUENT AND AT-W1 & AT-W2 ANAEROBIC ZONE INFLUENT (WEST) [6]



36 X 48 WATERMAN MODEL
SS-252-1-Y
SLIDE GATE

FOR: WALSH CONSTRUCTION II, LLC
3011 W. GRAND BLVD., SUITE 2300
DETROIT, MI 48202
PO: 212061P05
REF: ANN ARBOR WWTP
ANN ARBOR, MI

ENG: MALCOM PIRNIE

REV. NO.	DATE	(CUST. REV.)	BY	JOB NO.	PROJECT MANAGER
[6]	JAN. 31, '14	CL	DW	A19418L	DANNY WHITE
[4]	AUG. 8, '13	CL	RJ	WQ12-A-19418	CL DP/REM/DV REM
[6]	AUG. 7, '13	CL	DW	11	1 OF 1 [6]
[6]	MAY 24, '13	CL	DW	NTS	NOV. 9, '12
[6]	MAY 9, '13	CL	DW	RB-12-0414	

Attachment B – Soil Boring Report

Report

Aquifer Pumping Test Evaluation

Ann Arbor Wastewater Treatment Plant

Malcom Pirnie, Inc.
535 Griswold, Suite 1950
Detroit, Michigan 48226

NTH Project No. 15-050510-06
November 23, 2010

NTH Consultants, Ltd.
2000 Brush Street
480 Ford Field
Detroit, MI 48226



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GROUNDWATER ANALYTICAL DATA	APPENDIX D
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1.0 INTRODUCTION

This report was prepared by NTH Consultants, Ltd. (NTH) to present the evaluation of aquifer pumping test data for a flowing artesian (“artesian”) aquifer at the Ann Arbor Wastewater Treatment Plant (WWTP). The plant is located within the Huron River valley and is generally bordered to the north and south by high slopes. The site is located on the north side of the Huron River west of its confluence with Fleming Creek. Figure 1, Site Location Map, included in Appendix A, depicts the location of the site, referenced to nearby roads and major topographic features. The site is located in the eastern portion of Washtenaw County. At the time of this investigation, the average elevation of the Huron River was approximately EL 729.5 to 730.0, as estimated using river outfall data from the Ann Arbor WWTP.

As shown on Figure 1, Geddes Dam is located on the river approximately 1,500 feet west (upstream) of the wastewater treatment plant, near Old Dixboro Road. This dam is owned by the City of Ann Arbor. The dam’s spillway elevation is 747.57 feet, relative to mean sea level (EL 747.57). According to published reports, the original dam at this location was constructed in 1862. The dam was used for power generation until 1964. A flood in June 1968 washed out Geddes Dam, which was subsequently rebuilt by the City. The dam is currently used primarily to maintain Geddes Pond for recreation at approximately EL 748.

Beginning in May 2005, NTH conducted a geotechnical investigation at the Ann Arbor Wastewater Treatment Plant for Malcolm Pirnie, to evaluate the subsurface conditions in anticipation of a major renovation of the plant. To date, this investigation has included drilling 28 test borings, installing 8 shallow observation wells, installing one shallow test well, installing one deep pumping test well, and installing 5 pneumatic piezometers. Figure 2, Test Boring Location Plan, included in Appendix A, depicts the location of the on-site borings, wells, and piezometers referenced to site features.

During the project geotechnical investigation, some of the test borings encountered an artesian aquifer zone with a static piezometric elevation approximately 18 feet above existing ground surface (i.e., EL 757). Based on the apparent piezometric head present in this zone and the anticipated depth of excavations associated with the future plant renovations, the project team concluded that depressurization of the artesian aquifer may be necessary to prevent uplift of the excavation floor and/or groundwater leakage into the excavation

during construction. Accordingly, the project team recommended that an aquifer pumping test be performed to characterize the aquifer and identify the effort and effects of a depressurization program.

As such, an aquifer pumping test was performed at the site, as described in this report. The objectives of the aquifer pumping test were to develop estimates of the artesian aquifer hydraulic properties (i.e., transmissivity and storage coefficient) and to evaluate on a preliminary basis the possible extent of drawdown in the aquifer that may be expected due to implementation of a depressurization system. Groundwater sampling was also conducted as part of the aquifer pumping test for the purposes of classifying the water from the aquifer pumping test and a potential dewatering/depressurizing system.

To accomplish the proposed objectives for the artesian aquifer, we installed one 8-inch diameter pumping well (PW-2) in the artesian aquifer. This well was then used to conduct a 24-hour constant-rate pumping test. Piezometric elevations in the artesian zone were monitored during the test at each of the five existing pneumatic piezometers located at the site. In addition, to evaluate the possible influence of pumping the artesian aquifer on water levels in the upper unconfined groundwater unit, existing shallow observation wells were also monitored during the aquifer pumping test. We reviewed water level data collected during the constant-rate pumping test, and analyzed the data to estimate the aquifer properties. Subsequent sections of this report describe the well installation and test data collection procedures, the results of our evaluation, and conclusions.

2.0 GENERAL HYDROGEOLOGIC CONDITIONS

This section describes the regional and site-specific hydrogeologic conditions at the Ann Arbor Wastewater Treatment Plant, based on available information.

2.1 REGIONAL HYDROGEOLOGIC CONDITIONS

The description of regional hydrogeologic conditions is based on information from several published sources, including:

- *Water Resources of Washtenaw County, Michigan*, by F.R. Twenter, R.L. Knutilla, and J.O. Nowlin, USGS, 1976.

- *The Groundwater Geology and Hydrology of Washtenaw County and the Upper Huron River Basin*, by George R. Kunkle, Ph.D. dissertation, University of Michigan, 1960.
- *Report on Groundwater Resources for Public Water Supply*, by Shoecraft, Drury, and McNamee Engineers, 1935.

According to information provided in these references, the regional geologic setting in the Ann Arbor area is characterized by glacial moraine or outwash deposits overlying bedrock. The glacial deposits average approximately 200 feet thick with bedrock occurring at approximately EL 550. The wastewater treatment plant site is located near the interface between two underlying bedrock formations. To the west is the Coldwater Shale Formation, and to the east is the Sunbury-Berea-Bedford Formation. This latter rock group typically includes shale and sandstone.

The glacial deposits in the immediate vicinity of the Huron River consist predominantly of granular outwash deposits. These deposits extend into the area north of the river, where the topography is higher. The Huron River is typically underlain at depth by approximately 50 to 60 feet of sands and gravels that occur within an ancient channel.

Groundwater in Washtenaw County occurs in the glacial deposits and bedrock under either unconfined or confined conditions. Artesian conditions are known to occur, especially in the southeast portion of Washtenaw County. These conditions are produced when a confining layer such as clay or hardpan overlies an aquifer and the recharge zone for the aquifer is located at some distance away, at a substantially higher elevation, causing groundwater to flow at the surface.

Based on information provided by the Washtenaw County Road Commission, during construction of the nearby Dixboro Bridge in 2004, artesian groundwater was reported at several locations. The artesian groundwater was first discovered in several geotechnical borings during the geotechnical investigation, with one of the borings developing artesian conditions after being abandoned. Artesian conditions were again noticed after removing steel sheeting along the riverbank in preparation to construct the new foundations for the bridge.

During construction of the northern abutment and bridge pier, artesian conditions were again noted during sheeting installation. A well driller was called in to locally suppress the artesian pressure head during soil stabilization, necessary to construct the new foundations. The well driller reportedly had to drill numerous 2-inch diameter pilot wells in search for the artesian layer. After several failed attempts to locate the artesian layer, the driller successfully installed a 12-inch diameter well in the layer.

Currently, there are two boreholes associated with the Dixboro Bridge project that are observed to be leaking artesian groundwater and have not been sealed successfully after several attempts. On the south approach, a leaky artesian borehole is reported to be channeled to the adjacent swampy area via a french drain system. On the north abutment, a previous leaky artesian boring is channeled to the sheeting wall via pipe, and groundwater actively runs to the Huron River. The flow is visually estimated at approximately 60 gpm and is readily visible from the south abutment.

Regional hydrogeologic reports indicate that groundwater quality within the glacial deposits is generally suitable for potable water supply. Groundwater from some of the bedrock formations (e.g., Berea Sandstone, Coldwater Shale) occasionally contains elevated chloride concentrations.

2.2 SITE HYDROGEOLOGIC CONDITIONS

The site is located in eastern Washtenaw County on the north side of the Huron River. As shown on the site location map (Figure 1), the site is located in the valley defined by the Huron River, and the topography increases by up to 60 feet both north and south of the site to approximately Elevation 800 or greater. These uplands likely represent the recharge zone for the artesian aquifer. However, the exact location and extent of the recharge area has not been delineated. The site topography is generally flat with an average ground surface of approximately EL 740. The Huron River in this location is at approximately EL 729.5.

In addition to the historic regional information, the hydrogeologic conditions of the site have been characterized based primarily on descriptions of the subsurface soils encountered during the geotechnical investigation and installation of the pumping well (PW-2). The subsoil conditions generally consist of fill materials (sandy or clayey) or native sand to depths ranging from approximately 3 to 28 feet bgs, with an average depth of approximately 15 feet bgs. The fill materials and surficial granular soils are underlain by a

relatively thick deposit of hard silty clay, which includes occasional sand seams or layers. On the eastern side of the site, the hard gray silty clay extended to the maximum explored depths of the on-site test borings (i.e., max. 90 feet bgs at TB-201 – EL 648.6). On the western side of the site, several (but not all) of the relatively deep test borings encountered a granular zone below the hard gray silty clay. In most cases, this granular zone extended to the maximum explored depth of the on-site test borings (i.e., max. 95 feet at TB-202 – EL 643.0).

Note that one of the published references (Kunkle, 1960) includes information from a historic water well log, which is referenced as located at the “A. A. Sewage Treatment Plant” in Section 36 of Ann Arbor Township. For reference, a copy of the well log information is included in Appendix B. The subsurface description provided on this historic well log includes 5 feet of surficial granular soil, 25 feet of “yellow clay,” 54 feet of “hard blue clay,” and 30 feet of granular soil. The total depth of the well is listed as 114 feet (EL 625). It is not clear at what interval the well was screened; however, the stratum between 91 and 105 feet bgs is described as “sand and gravel,” which likely represents the primary water-bearing zone. The granular soil above and below this stratum is described as finer material. No information regarding the static water level in the well is provided on the log.

Also, a review of regional water supply well records from the Michigan Department of Environmental Quality (MDEQ) on-line database revealed a log for a water well installed in 1969 at the Ann Arbor Wastewater Treatment Plant address (i.e., 49 S. Dixboro Road). For reference, a copy of the well log is included in Appendix B. The subsurface description provided on this historic well log includes 12 feet of “blue clay,” 2 feet of “sand,” 79 feet of “blue clay,” and 2 feet of “gravel.” The total depth of the well is listed as 96 feet. The static water level is noted as 18 feet above ground, and the well is described as flowing at 100 gpm. During the on-site geotechnical investigation by NTH, groundwater was encountered sporadically in the upper fill or sandy soils under unconfined conditions.

Of interest for this report, groundwater was encountered under artesian (flowing) conditions in the granular zone below the hard silty clay at several (but not all) of the relatively deep test borings. The artesian groundwater zone was encountered at TB-107, TB-202, TB-203B, TB-302, TB-307A, and TB-308, as evidenced

by significant groundwater flow from the borehole and/or measured static groundwater levels above ground surface using stacked casing during drilling.

Static groundwater levels measured in stacked casing at these locations during drilling ranged from approximately 12 to 24 feet above ground surface (EL 749.9 to 760.4). The granular zone containing the artesian groundwater zone was encountered at the above-listed test boring locations at depths ranging from approximately 37.5 feet below ground surface (bgs) at TB-107 (EL 703.3) to 82.5 feet bgs at TB-203B (EL 659.3).

Specific information regarding the granular unit that comprises the artesian zone at each test boring, including the depth, elevation, description, piezometric level, and estimated groundwater flow rate, is summarized below on Table 1. This information is also provided on the individual Logs of Test Boring, which are included in the Geotechnical Investigation Report for the project that has been prepared by NTH and will be presented under separate cover.

As indicated on Table 1 below, at most locations the artesian aquifer zone was encountered at depths of between 67 and 82.5 feet bgs (EL 671.0 to 659.3). At the two test borings located in the northern part of the site (TB-107 and TB-308), the artesian aquifer zone was encountered considerably higher, at 37.5 and 42.0 feet bgs (EL 703.3 and 699.2), respectively. However, both of these locations exhibited considerable groundwater flow from the test boring, and the static piezometric elevations measured at PZ-107 (EL 756.0 to 757.9) and TB-308 (EL 759.3) were similar to those measured at the other piezometers. Therefore, the artesian aquifer zone encountered at TB-107 and TB-308 apparently represents the same artesian unit that occurs elsewhere at the site.

Based on collected soil samples, the composition of the soil within the artesian unit ranged from “silty sand with a trace of gravel” to “sand and gravel with a trace of silt.” At both TB-202 and PW-2, the upper portion of the artesian unit included a series of interbedded clay layers.

At PW-2, the subsoils consisted of cohesive fill material below the asphalt pavement to a depth of approximately 8 feet, followed by hard gray silty clay to a depth of approximately 71 feet. The gray silty clay

was underlain by layers of compact gray sand and gravel and interbedded hard gray silty clay with some gravel to the maximum depth drilled of 95 feet (EL 643.1).

Groundwater was encountered at PW-2 in the granular soils under artesian conditions. The static water levels measured after drilling and well development indicated an artesian head of approximately 17.5 feet above ground surface (EL 755.6).

**Table 1: Information on Artesian Groundwater Zone
Encountered at Specific Test Boring Locations**

Test Boring Designation	Artesian Unit Granular Soils			Artesian Groundwater Conditions	
	Depth Encountered	Elevation Encountered	Soil Description	Static Piezometric Level	Artesian Flow Observations
	ft (bgs)	EL		feet above ground/EL	
TB-107	37.5 to 40 (EOB)	703.3 to 700.8	SAND & GRAVEL with Trace Silt	17.1/758.0	Estimated 65 gpm
TB-202	67 to 95 (EOB)	671.0 to 643.0	SAND with Trace Silt and Gravel (Interbedded Clay Layers)	16.4/754.4	Estimated 165 gpm
TB-203B	82.5 to 94.9 (EOB)	659.3 to 646.9	SAND with Some Gravel and Trace Silt	13.1/754.9	Estimated 150 gpm
TB-301	81.0 to 82.5	659.5 to 658.0	GRAVEL & SAND	N/A	"No Artesian Flow"
TB-302	79 to 88.5 (EOB)	658.8 to 649.3	SILTY SAND with Trace Gravel	12.1/749.9	Estimated 60 gpm
TB-303	Not Encountered (EOB - 40.0)	Not Encountered to EL 700.5	N/A	N/A	N/A

Test Boring Designation	Artesian Unit Granular Soils			Artesian Groundwater Conditions	
	Depth Encountered	Elevation Encountered	Soil Description	Static Piezometric Level	Artesian Flow Observations
	ft (bgs)	EL		feet above ground/EL	
TB-304	Not Encountered (EOB - 90.0)	Not Encountered to EL 657.5	N/A	N/A	N/A
TB-306	83.5 to 86.0	652.6 to 650.1	SILTY SAND with Trace Clay	N/A	"No Artesian Flow"
TB-307A	74 to 76 (EOB)	661.9 to 659.9	SAND & GRAVEL with Trace Silt	24.5/760.4	Estimated 60 to 200 gpm
TB-308	42.0 to 60.0 (EOB)	699.2 to 681.2	SAND & GRAVEL with Trace Silt & Clay	18.1/759.3	Estimated 195 gpm
PW-2	71 to 95 (EOB)	667.1 to 643.1	SAND & GRAVEL (Interbedded Clay Layers)	17.5/755.6	Estimated 150 to 375 gpm

Table 1 Notes:

1. Soil descriptions, static piezometric level, and artesian groundwater flow observations are based on conditions observed during drilling each test boring, as documented on the respective Log of Test Boring within the project Geotechnical Investigation Report or the respective Log of Monitoring Well.
2. bgs – below ground surface
3. EOB – End of Boring
4. gpm – gallons per minute; flow rate estimated based on height of flowing water column above top of casing
5. N/A – Not Applicable

The aquifer pumping test utilized five existing pneumatic piezometers installed in the artesian aquifer during previous geotechnical investigations by NTH. These piezometers consisted of PZ-107, PZ-202, PZ-203, PZ-302, and PZ-307A installed in the correspondingly numbered test borings. For reference, Appendix B includes a Log of Pneumatic Piezometer, which shows the construction details for each of the pneumatic piezometers. Test boring logs that provide more detailed information on the subsurface conditions encountered at each pneumatic piezometer location are included in the Geotechnical Investigation Report for the project that has been prepared by NTH and will be presented under separate cover.

As shown on the Logs of Pneumatic Piezometer, the sensor tips for these piezometers were generally installed several feet above the granular stratum containing the artesian aquifer due to the influx of granular aquifer material after flushing the drilling fluids from the borehole with clean water. Note that, following installation, the pressure readings from the pneumatic piezometers generally agreed with the measured static groundwater elevations, ensuring that the pneumatic piezometers are representative of conditions within the artesian aquifer zone.

3.0 PUMPING WELL INSTALLATION

The pumping well used for the test is designated as “PW-2” and was installed approximately 10 feet southeast of PZ-202. During the period of August 21 through 29, 2006, a licensed water well driller, Raymer Company, Inc. (Raymer), installed the pumping well under the observation of NTH. The well log prepared by NTH for PW-2, which provides details of the well’s construction, is included as Figure 5 in Appendix B, Well Logs. As indicated on the well record, the pumping well was installed using cable tool techniques to a depth of 95 feet bgs. PW-2 was constructed with 8-inch diameter steel casing with a 10-foot, 6-inch diameter, 20-slot, well screen set from 80 to 90 feet bgs (EL 658.1 to 648.1). For reference, Appendix B also includes the “Water Well and Pump Record” that was prepared by Raymer.

Cable tool drilling techniques are performed by repeatedly lifting and dropping a heavy string of drilling tools into the borehole. The drill bit loosens the subsurface material while the reciprocating action of the tools mixes the loosened particles with water to form a slurry (drilling fluid) at the bottom of the borehole. Soil cuttings accumulate in the slurry as drilling proceeds and eventually the impact of the drill bit is reduced. When the penetration rate becomes unacceptable, the drilling fluid is removed from the borehole by a sand bailer. The well casing is driven into the ground as the drilling and bailing proceeds.

To lubricate the outside of the casing, provide a seal, and prevent groundwater flow around the outside of the casing, Raymer added granular bentonite (Benseal®) from the surface to the annulus around the outer edge of the casing as it was driven downward.

After reaching a depth of approximately 95 feet (EL 643.1), Raymer bailed the casing to remove the drilling fluid. The well screen attached to a tri-seal packer was then placed inside the casing and pushed with the drill bit to its intended depth of 90 feet (EL 648.1). The casing was then retracted to a depth of 80 feet (EL 658.1) to expose the well screen.

The well screen was specifically designed by Raymer based on the grain size analysis of the aquifer material encountered at PW-2. This design was reviewed and approved by NTH. Figure 5A in Appendix B, presents the grain size distribution curve for the aquifer sample collected by Raymer during drilling. The sample was collected from the material removed via bailer within the screened interval, between depths of 80 and 90 feet bgs (EL 658.1 to 648.1). The screen slot opening was chosen to permit removal of the fine material from the formation during well development, thereby creating a zone of increased porosity and permeability near the well. As outlined in *Groundwater and Wells* (Driscoll, 1986), according to accepted practice for naturally-developed wells (i.e., no gravel filter pack), the slot width (0.020-inch) was selected based on a 50 percent retention of the formation material adjacent to the screen (i.e., 50 percent passing). In general, samples taken via the bailer method do appear somewhat coarser than samples taken via test boring samples the finest silt and/or clay is often suspended or washed out. However, the screened design used by Raymer has been historically calibrated to account for this effect and as described later did prove to be an effective screen for this pump test.

Development of the well was completed by allowing the well to flow under artesian head and by using the air development method. Between August 29 and 30, 2006, the well was allowed to flow under artesian head with occasional surging with the sand bailer for a total of approximately 2 hours. On August 31, 2006, air development was performed using an air compressor to force air through the well screen. Both methods enabled the loosening and removal of fines (i.e., clay, silt, fine sand) from the formation around the well.

Following completion of the aquifer pumping tests, Raymer abandoned PW-2 on October 4, 2006. The drop pipe and pump were removed, and the well casing was driven past the bottom of the well screen to a depth of 90.8 feet bgs (EL 647.3) to seal off the well screen from the aquifer. The top of the casing string was then extended approximately 23 feet to prevent the well from flowing during abandonment. The well was filled with neat cement pumped to the bottom of the well using tremie methods. Raymer then removed the

excess casing down to the first threaded coupling below grade (i.e., approximately 6 feet bgs) and the upper portion of the borehole was filled with neat cement. A flush-mount monitoring well cover was installed in the pavement to mark the former well location. NTH has prepared a Log of Well Abandonment, included as Figure 6 in Appendix B, which documents the well abandonment methods and illustrates the depth of the well components that were left in place.

4.0 ARTESIAN AQUIFER PUMPING TEST DESCRIPTION

This section describes the methods for obtaining readings from the pneumatic piezometers and observation wells that were included in the aquifer pumping test at the site and the associated pump test procedures.

4.1 PIEZOMETER/OBSERVATION WELL READING METHODS

Pneumatic piezometers PZ-107, PZ-202, PZ-203, PZ-302, and PZ-307A were monitored during the aquifer pumping test. Slope Indicator® pneumatic indicators (“read-out boxes”) were used to manually record the groundwater pressure at each of these locations. For reference, Appendix B includes a copy of the manufacturer’s description of the construction and operation of a pneumatic piezometer and the indicator. The precision of the pneumatic indicators that were used at four of the piezometers (PZ-107, PZ-202, PZ-203, PZ-307A) was ± 0.1 pounds per square inch (psi), which equates to approximately ± 0.25 foot of water. The precision of the pneumatic indicator at PZ-302 was ± 0.25 pounds per square inch (psi), which equates to approximately ± 0.6 foot of water. Note that the drawdown that was observed at each piezometer during the aquifer pumping test was several times greater than the precision of the respective indicator. Therefore, lack of precision is not an issue, and the pneumatic piezometer data can be used to analyze the aquifer pumping test.

In addition to monitoring piezometric levels in the artesian zone during the aquifer pumping test, groundwater levels in the upper unconfined zone were also observed using shallow observation wells installed during the previous phase of the geotechnical investigation. The purpose of these measurements was to evaluate the possible effects of pumping the artesian aquifer on groundwater levels within the upper unconfined zone. Groundwater levels were continuously recorded in four of the shallow observation wells (PW-1, MW-103, MW-105, MW-106) installed during the geotechnical investigation. These particular wells

were chosen based on close proximity to the pumping well (i.e., area to be de-pressurized) or because the shallow well was paired with a deeper pneumatic piezometer. The complete period of record for these wells extended from September 1 through September 11, 2006. In addition to the continuous groundwater level measurements, groundwater levels were also measured periodically at the above-listed observation wells and at two other observation wells (MW-101 and MW-104) before, during, and after the aquifer pumping test. For reference, Appendix B includes the Logs of Observation Well for each of these wells.

4.2 AQUIFER PUMPING TEST PROCEDURES

To evaluate the hydraulic properties of the artesian aquifer, a 24-hour constant-rate pumping test was completed using PW-2 as the pumping well. The test included the following phases:

Step Pumping Test - On September 5, 2006, Raymer installed the test pump and performed a limited “step test” as described below. The pump used for the test was a Berkeley® 6-inch diameter, 2-stage, 25 horsepower, submersible turbine pump. According to the manufacturer’s information, this pump is capable of producing between 211 and 650 gpm. The pump was installed slightly above the top of the well screen, at a depth of approximately 79 feet bgs (EL 659.1). The pump intake was located at a depth of 72.2 feet bgs (EL 665.9).

The step test was performed by initially pumping the well at a rate of approximately 200 gpm until sediment-free water was observed coming from the well to complete the well development. The pumping rate was then increased successively to 230 gpm and 260 gpm. At 260 gpm the pump lost suction (i.e., the water level in the well fell below the pump intake) after approximately 15 minutes. The results of this step test were used to evaluate the appropriate pumping rate that could be sustained for the entire 24-hour constant rate test.

Constant-Rate Pumping Test – A constant-rate pumping test was initially attempted on September 6, 2006. Raymer began pumping PW-2 at a rate of approximately 220 gpm at 10:17 a.m. After approximately 6 hours, it was discovered that incorrect pneumatic pressure readings had been obtained at PZ-302. Because data from this location was compromised, this initial test was aborted. The pump was shut off, and the aquifer was allowed to recover to static conditions.

A second constant-rate pumping test was initiated the following day, at 9:25 a.m. on September 7, 2006, and was completed after approximately 24.5 hours at 10:00 a.m. on September 8, 2006. Prior to initiating this test, static piezometric elevations were recorded at each of the pneumatic piezometers and static groundwater elevations were recorded at each of the shallow observation wells. The static piezometric elevations recorded at the pneumatic piezometers prior to the aborted test, prior to the second completed test, and at two times during the recovery period are presented below in Table 2.

Table 2: Static Groundwater Elevations Prior to Pumping Tests and After Recovery Period

	PZ-202	PZ-302	PZ-107	PZ-203	PZ-307A	PW-2
August 2006	754.7	755.7	756.2	757.0	759.6	755.6
9/6/2006 Prior to Pumping	753.7	[1]	756.5	[1]	760.5	756.8
9/7/2006 Prior to Pumping	753.5	754.5	756.0	757.0	761.7	[2]
9/8/2006 End of 6-hr Recovery	753.0	754.5	756.9	756.1	760.8	[2]
9/11/2006 Full Recovery	754.5	755.4	757.4	757.7	760.3	[2]

Notes:

[1] Possible operator error affected reading. Pump test started on 9/6/06 was aborted; data not analyzed.

[2] Direct measurement of the static groundwater level at PW-2 was not feasible due to configuration of wellhead with pump installed.

While the above readings generally represent static conditions, there is some variability among the readings at each piezometer before and after the tests. Most of this variability may be due to the inherent lack of precision for the pneumatic piezometer indicators. As discussed previously, the precision of the indicators may range from approximately ± 0.25 foot to ± 0.6 foot of water. Also, we found that there was some variation between individual indicators. For the aquifer pumping test and recovery readings, a specific indicator was dedicated for use at each piezometer (typically the same operator also took the readings at each piezometer),

to eliminate this potential source of variability from the data to be analyzed. However, the readings from August 2006 and September 11, 2006, were all taken with the same indicator.

We note that the piezometric elevations observed at PZ-202 immediately prior to the aquifer pumping tests were slightly lower than historic elevations at this location. Although every effort was made by Raymer to minimize leakage around the wellhead after the pump was installed in PW-2, a small amount of leakage could not be stopped due to the artesian condition. During this time, the piezometric surface in the immediate vicinity of the well, including at PZ-202, may have been slightly depressed.

In summary, although some variability was observed in the piezometric elevations measured before and after the test period, these variations do not affect the reliability of data with respect to the aquifer pumping test analysis. The test analysis is based on changes measured at the individual locations during the aquifer pumping test and recovery period only. The test was conducted and monitored in a manner designed to minimize potential uncertainties.

During the second, completed pumping test (September 7, 2006), PW-2 was pumped continuously at a constant rate of approximately 215 gpm. The pumping rate was monitored by on-site NTH personnel using an analog flow meter to verify the constant pumping rate. The flow meter also totalized the pumping volume, from which an average flow rate during the test was calculated as 214.7 gpm.

The water level in the pumping well (PW-2) was recorded during the test with a pressure transducer and electronic datalogger (Hermit 3000®). In addition, the water level in the pumping well was measured periodically using a manual water level indicator tape. The water level data obtained at PW-2 during the constant-rate pumping test have been plotted, and provided in Appendix C, Water Level Data Plots.

NTH personnel recorded piezometric levels at each of the five selected piezometers (PZ-107, PZ-202, PZ-203, PZ-302, and PZ-307A) throughout the constant-rate pumping test using the pneumatic read-out boxes. In accordance with guidelines for aquifer pumping tests developed by the MDEQ Water Bureau, pressure readings were generally recorded at regular time intervals, as follows:

<u>Test Duration</u>	<u>Frequency</u>
0 to 10 minutes	Every 1 minute
10 to 20 minutes	Every 2 minutes
20 to 60 minutes	Every 5 minutes
60 to 180 minutes	Every 15 minutes
180 to 360 minutes	Every 30 minutes
360 minutes to end of test	Every 60 minutes

The piezometric level data obtained at each piezometer location during the constant-rate pumping test have been plotted, and individual graphs for each piezometer are provided in Appendix C, Water Level Data Plots.

During the aquifer pumping test, barometric pressure was continuously recorded using the Hermit 3000® datalogger installed in the pumping well. The weather station at the wastewater treatment plant also records barometric pressure on an hourly basis. The data from both of these sources has been plotted and is presented in Appendix C.

During the aquifer pumping test, water level data from the shallow, unconfined unit was continuously recorded using LevelTroll® dataloggers installed in four of the shallow observation wells (PW-1, MW-103, MW-105, and MW-106). This data has been plotted and is presented in Appendix C. Manually-recorded water level data from shallow observation wells MW-101 and MW-104 was plotted and is also included in Appendix C.

The groundwater produced during the aquifer pumping test was discharged through a combination of piping and hoses to the adjacent primary concrete splitter structure located approximately 150 feet east of PW-2. The structure contains a series of adjustable weirs and operates to split the incoming flow to the eastern and western portions of the plant during normal flow. This structure also diverts flow to the retention basin during times at which incoming flow exceeds capacity. During the aquifer pumping test, water was pumped directly past the overflow weir to the retention basin. At no time during the test was water discharged or allowed to accumulate on the ground surface. Therefore, the discharge water did not infiltrate to either the shallow unconfined unit or the artesian aquifer and did not affect groundwater elevations recorded during the test.

Recovery Period – At the conclusion of the constant-rate pumping test (10:00 a.m. on September 8, 2006), NTH recorded piezometer level readings in each of the piezometers for approximately 6 hours as the aquifer recovered to within approximate 10 percent of the pre-test levels. We collected pressure readings on approximately the same schedule, as provided above, through the recovery period after the pump was shut off. Table 2 presented above includes the piezometric/groundwater elevations recorded after the 6-hour recovery period. We also collected an additional set of piezometric/groundwater elevation measurements on September 11, 2006, approximately 60 hours after the pump was shut off. The piezometric level data from each piezometer during the recovery phase has been plotted, and individual graphs for each piezometer are provided in Appendix C.

5.0 GROUNDWATER SAMPLING

During the geotechnical investigation, NTH collected samples of the artesian groundwater flowing from test boring TB-307A (PZ-307A) on July 28 and August 1, 2006. The samples were collected directly into laboratory-prepared sample containers with appropriate preservatives. During the first sampling event on July 28, 2006, we collected field measurements of dissolved oxygen and pH, using calibrated field meters. Groundwater had been flowing from the borehole at approximately 60 gpm for 0.5 hours prior to sampling.

We submitted the groundwater samples collected on July 28, 2006 to Brighton Analytical, L.L.C., for analysis of iron oxide (as expressed in total iron), hardness, chloride, hydrogen sulfide, total dissolved solids and iron bacteria. We submitted the groundwater sample collected on August 1, 2006, to RTI Laboratories, Inc., for analysis of dissolved carbon dioxide.

On August 30, 2006, following installation of the pumping well (PW-2) that was used for this evaluation, Malcolm Pirnie personnel collected groundwater samples from PW-2. Malcolm Pirnie personnel also collected groundwater samples from PW-2 during the aquifer pumping test on September 7, 2006. On each occasion the samples were collected directly from the well discharge after several hours of pumping. The samples were collected into laboratory-prepared sample containers with appropriate preservatives.

The groundwater sample collected on August 30, 2006, was submitted to Brighton Analytical, L.L.C., for analysis of ammonia-nitrogen, available cyanide, biochemical oxygen demand (BOD), chloride, dissolved iron, hardness, total dissolved solids (TDS), total suspended solids (TSS), total phosphorus, total phenols, fecal coliform, total metals (antimony, arsenic, barium, beryllium, boron, cadmium, chromium, copper, iron, lead, nickel, mercury, silver, selenium, thallium, zinc), volatile organic compounds (VOCs), and semi-volatile organic compounds (SVOCs). The groundwater sample collected on September 7, 2006, was submitted to Brighton Analytical, L.L.C., for analysis of available cyanide.

The groundwater quality analytical data from each of the sampling events has been tabulated and is included in Appendix D, Groundwater Analytical Data. The laboratory analytical reports from Brighton Analytical, L.L.C., and RTI Laboratories, Inc., are also included in Appendix D.

6.0 DATA ANALYSIS & EVALUATION

This section describes the results of the aquifer pumping test and the evaluation of potential effects from a groundwater depressurization system for the project.

6.1 AQUIFER PUMPING TEST RESULTS

As indicated previously, the constant-rate pumping test at PW-2 was performed at a rate of approximately 214.7 gpm for a period of 24.5 hours. At the end of the constant-rate pumping test, the water level in the pumping well (PW-2) was approximately 68.5 feet below the top of the well casing (EL 674.8) while the pump was still operating. This equates to a drawdown of approximately 82 feet below static level and approximately 63.3 feet bgs. The approximate configuration and extent of the drawdown cone that developed at the conclusion of the constant-rate pumping test is presented on Figure 3, Pumping Test Drawdown Contour, included in Appendix A.

We initially analyzed the time versus water level data from the piezometers using the solution developed by Theis (1935). This solution method is applicable to confined aquifers. Review of the data plots indicated that each drawdown curve became somewhat flatter and deviated from the Theis curve during the latter portion of the test. This behavior is indicative of a “leaky confined” condition. Therefore, we analyzed the

time versus water level data from the piezometers using the solution for a leaky confined aquifer developed by Hantush and Jacob (1955). Analysis of the aquifer pumping test data was completed using the computer program AQTESOLV® for Windows, Version 3.5. Plots of the data for each piezometer, including the results of the test analysis, are presented in Appendix E.

We also analyzed the time versus water level data from the piezometers during the recovery phase using the modified Theis solution. Although this solution is applicable to a non-leaky confined aquifer, the effect of the leaky condition is typically not as pronounced during the recovery phase, and the results from this analysis also provide a check of the aquifer pumping test analysis. Plots of the data for each piezometer, including the results of the test analysis using this solution method, are presented in Appendix E.

According to the established analytical techniques, for the Hantush and Jacob solution, the time versus drawdown data is plotted on logarithmic axes and values of transmissivity (T) and storativity (S) for the aquifer are estimated. For the modified Theis Recovery solution, the residual drawdown is plotted as a function of $\log(t/t')$ on semi-logarithmic axes, where t is the time since pumping began and t' is the time since pumping stopped. From this plot, the values of T and S/S' are estimated by drawing a straight line through the data. S/S' represents the ratio of the storativity during pumping (S) to the storativity during recovery (S'). Without the influence of boundary effects, the value of S/S' determined from the data plot should be close to unity. A value of $S/S' > 1.0$ suggests the influence of a recharge boundary during the test. Conversely, a value of $S/S' < 1.0$ suggests the presence of a barrier or no-flow boundary.

Table 3, Summary of Hydraulic Properties of Artesian Zone presented below, presents the results developed from each of the test analysis techniques. Analysis of the aquifer pumping test data from the piezometers using the leaky confined aquifer model, which we believe best represents the actual conditions, indicates that the transmissivity of the water-bearing granular soil averages approximately 25,500 gallons per day/foot (gpd/ft). The storage coefficient (S) of the aquifer averages approximately 0.002. The analyses using the Theis Recovery solution indicate a value of S/S' ranging from 1.0 (PZ-203) to 11.5 (PZ-107). As noted above, a value of $S/S' > 1.0$ suggests the influence of a recharge boundary. These results may also be consistent with the behavior of a leaky aquifer, which would exhibit less drawdown than a completely confined aquifer due to the additional source of water to the system.

The AQTESOLV® program requires that a value be input for the aquifer thickness. However, this parameter does not affect the estimated values for transmissivity or storage coefficient that are developed from the aquifer pumping test analysis. Because none of the on-site test borings extended to the bottom of the artesian aquifer, we assigned a value of 21 feet for the estimated aquifer thickness in the program, based on the maximum thickness of the granular unit penetrated by the on-site test borings (TB-202). However, the total thickness of the artesian aquifer at the site is not known.

Table 3: Summary of Hydraulic Properties of Artesian Zone

Piezometer Designation	Hydraulic Property Estimates Using Specified Method					
	Hantush-Jacob Leaky Method		Theis Recovery Method			
PZ-202 (10 feet West of PW-2)	T =	21,500	gpd/ft	T =	24,900	gpd/ft
	S =	0.0017		S/S' =	5.2	
	r/B =	0.017				
PZ-302 (110 feet South of PW-2)	T =	31,100	gpd/ft	T =	30,300	gpd/ft
	S =	0.0009		S/S' =	2.2	
	r/B =	0.041				
PZ-107 (155 feet North of PW-2)	T =	13,400	gpd/ft	T =	24,700	gpd/ft
	S =	0.025		S/S' =	11.5	
	r/B =	0.05				
PZ-203 (240 feet South-Southwest of PW-2)	T =	40,100	gpd/ft	T =	35,000	gpd/ft
	S =	0.0003		S/S' =	1.0	
	r/B =	0.026				
PZ-307 (340 feet Southeast of PW-2)	T =	29,900	gpd/ft	T =	34,500	gpd/ft
	S =	0.0058		S/S' =	7.5	
	r/B =	0.05				
Average Properties (Geometric Mean)	T =	25,481	gpd/ft	T =	29,542	gpd/ft
	S =	0.0023		S/S' =	3.97	
	r/B =	0.034				

Notes:

- 1) gpd/ft - gallons per day/foot
- 2) T - transmissivity
- 3) S - storativity
- 4) r/B - dimensionless leakage factor, based on the ratio of hydraulic conductivity and thickness of the aquifer to the hydraulic conductivity and thickness of the aquitard.
- 5) S/S' - ratio of storativity during pumping (S) to the storativity during recovery (S').

Based on the estimated average transmissivity (25,500 gpd/ft) and the maximum aquifer thickness encountered at the on-site test borings (21 feet) the hydraulic conductivity (k) of the aquifer is calculated as 1,215 gallons per day/ foot² (gpd/ft²) or 5.7×10^{-2} centimeters per second (cm/sec). Based on the minimum aquifer thickness encountered (2 feet at TB-307A), the hydraulic conductivity is calculated as 12,750 gpd/ft² (6×10^{-1} cm/sec). Each of these estimated hydraulic conductivity values are indicative of clean sand or fine gravel (Groundwater – Freeze and Cherry, 1979).

We also evaluated the water level data by assuming steady-state conditions at the conclusion of the constant-rate pumping test and calculating the aquifer transmissivity and storativity using the distance versus drawdown technique developed by Theim (1962). The measured drawdowns at the piezometers after pumping for 24.5 hours are presented on Table 4 below.

Table 4: Drawdown at End of Aquifer Pumping Test

Piezometer Designation	Distance from Pumping Well	Drawdown After 24 Hours
PZ-202	10 feet	8.77 feet
PZ-302	110 feet	4.61 feet
PZ-107	155 feet	3.23 feet
PZ-203	240 feet	3.92 feet
PZ-307	390 feet	1.85 feet

The distance/drawdown plot is presented in Appendix E. Our analysis of the distance/drawdown data from the end of the 24-hour pumping test results in a transmissivity of 27,445 gpd/ft and storativity of 0.005, which generally agree with the values estimated from time versus drawdown data.

The distance versus drawdown plot also provides an indication of the approximate extent of drawdown in the aquifer that was induced during the aquifer pumping test. By extrapolating the approximate straight line through the points representing the piezometers, the drawdown cone is estimated to have extended a maximum of approximately 1,300 feet away from the pumping well by the end of the 24-hour pumping test. This represents the distance where the drawdown in the aquifer was essentially zero. The actual limits

of drawdown that could be expected to have a perceptible impact on the aquifer (e.g., 1 foot) were likely less than 1,000 feet.

In addition, the on-site test borings indicated that the artesian unit is apparently not continuous in all directions. Therefore, the limits of drawdown in the aquifer would not propagate uniformly in all directions. The drawdown cone would be considerably impeded in the direction where recharge boundaries may have been encountered, and may have extended to greater than the calculated distance if a no-flow boundary was encountered or if the transmissivity of the aquifer changes laterally.

During the aquifer pumping test, water level data from the shallow, unconfined unit was continuously recorded using LevelTroll® transducers and dataloggers. This data was plotted and is presented in Appendix C. Review of the data plots indicates there was no evidence of an effect on the shallow groundwater unit from pumping the artesian aquifer. Water level fluctuations observed in the two shallow wells located closest to the Huron River (PW-1 and MW-103) appear to correlate with similar fluctuations in the river level. For reference, the Huron River water surface elevation, as recorded at the Ann Arbor WWTP, was also plotted and is presented in Appendix C. This graph also includes the rainfall recorded at the Ann Arbor WWTP weather station. Review of the river water level data shows periodic variability of less than approximately 0.1 foot, as well as occasional larger variations that appear to be related to precipitation events. Comparing the plots for the shallow groundwater levels at PW-1 and MW-103 shows similar short-term variation. However, the variations do not appear to correlate with either the period when the aquifer pumping test was conducted or the recovery period.

The shallow groundwater level at MW-105 exhibited a relatively gradual change of approximately 0.1 foot over the period of record. However, the variation does not appear to correlate with either the period when the aquifer pumping test was conducted or the recovery period.

The shallow groundwater level at MW-106 exhibited daily fluctuations of approximately 0.1 foot, as well as an overall gradual variation of approximately 0.2 foot. The cause of this variability is not readily apparent. Again, however, the variation does not appear to correlate with either the period when the aquifer pumping test was conducted or the recovery period.

Note that a separate investigation of the shallow groundwater conditions at the Ann Arbor WWTP was completed by NTH. The results of that investigation, including an evaluation of groundwater control measures that may be necessary during construction, are included in the Geotechnical Investigation Report for the project that has been prepared by NTH and will be presented under separate cover.

6.2 POTENTIAL EFFECTS OF AQUIFER DEPRESSURIZATION

This section presents our evaluation of the theoretical influence on the artesian aquifer due to long-term operation of a depressurization system at the site. The depressurization requirements and configuration of such a system have not yet been determined and will depend on the size, depth, and staging of excavations associated with the construction project. However, for purposes of the evaluation, we have developed an estimate of the expected response of the aquifer to a pumping system at the site. Three different scenarios were modeled; one pumping at a total rate of 1,000 gpm, one pumping at a total rate of 2,000 gpm, and one pumping at a total rate of 3,000 gpm. We evaluated the system using an analytical groundwater model (Welflo®) developed by Walton (1988). The analysis assumes a leaky confined aquifer that is homogeneous and isotropic, having a transmissivity of 25,500 gpd/ft and storativity of 0.002, based on the aquifer pumping test results. The specified total pumping rate was assumed to occur at a single, large-diameter (e.g., 100-foot) point source, which would be representative of a site dewatering system with respect to the scale of the drawdown area.

As a basis for determining the “zone of influence,” a drawdown of 2 feet was defined as the amount of drawdown that could be measurable and which could potentially have a noticeable effect on existing water supply wells or surface water features. The theoretical zone of influence will spread out equally in all directions over time as the depressurizing system is operated. The actual drawdown cone will likely be different and will be influenced by the recharge sources in the area (i.e., uplands and surface water features) and will not spread equally in all directions. The drawdown cone will be considerably impeded in the direction where recharge boundaries are encountered, and may extend to greater than the calculated distance if a no-flow boundary is encountered or if the transmissivity of the aquifer changes laterally. However, if a no-flow boundary such as a thick clay or hardpan layer is encountered, the required pumping rate to achieve a required drawdown would decrease, thereby reducing the zone of influence extent.

Nonetheless, the calculated theoretical radius of influence does give some sense of the potential effect that pumping may have on the surrounding aquifer. Using the analytical model, and the aquifer parameters estimated from the aquifer pumping test ($T = 25,500$ gpd/ft and $S = 0.002$), we calculated the zone of influence that is expected to develop over time. A graph presenting the Calculated (Theoretical) Zone of Influence vs. Time of Pumping is included in Appendix E. As shown on this graph, for each of the three pumping rates the zone of influence initially spreads out, but then essentially stabilizes within approximately 10 days. After this time, the zone of influence may be expected to extend up to a distance of approximately 4,000 feet (0.75 mile) for the 1,000-gpm scenario or up to approximately 6,500 feet (1.25 mile) for the 3,000-gpm scenario.

To illustrate the area that could be affected, we prepared Figure 4, Estimated Theoretical Zone of Influence, included in Appendix A. This map includes an outline of the 4,000-foot; the 5,500-foot; and the 6,500-foot zones of influence, approximately centered on the anticipated excavation area at the plant. As shown, the theoretical zones of influence encompass the relatively sparse residential area north of the plant, the commercial developments along Huron River Drive south of the plant, and Geddes Dam located upstream of the wastewater treatment plant.

6.3 GROUNDWATER QUALITY ANALYTICAL RESULTS

The analytical results for the groundwater samples collected from the artesian aquifer are summarized on Table D-1, Summary of Chemical Analyses, in Appendix D. For reference, this table includes the residential drinking water criteria and the groundwater-surface water interface (GSI) criteria developed by the MDEQ under Part 201 of P.A. 451. Comparison of the analytical data to these criteria indicates that only one parameter (cyanide) was detected at a concentration slightly above the GSI criteria.

The groundwater samples collected during this investigation are considered to be generally representative of groundwater that would be produced from wells installed in the artesian aquifer at the site. Potentially, depending on the extent and duration of pumping, a depressurization system at the site could induce migration of groundwater from adjoining areas or from different vertical strata. Therefore, the chemical composition of groundwater produced from the pumping system could gradually change over time and should be sampled periodically for appropriate analytes.

7.0 LIMITATIONS

This report is intended for specific use in evaluating the depressurizing properties for the artesian aquifer represented by PW-2 installed at the Ann Arbor Wastewater Treatment Plant, in Ann Arbor, Michigan, as described in this report. The work was performed in accordance with the prevailing standard of practice in this area at the time the work was performed. No other warranty, expressed or implied, is provided or intended.

The scope of the present study was limited to estimation of the aquifer characteristics (transmissivity and storage coefficient) of the artesian aquifer, based on the data obtained during the aquifer pumping test, and to evaluate on a preliminary basis the possible extent of drawdown in the artesian aquifer that may be expected due to implementation of a depressurization system during construction activities at the site. The work did not address the potential impact of the depressurizing system on specific surrounding wells, lakes, streams, or wetlands. Such an effort would involve locating nearby wells and surface water features, and reviewing information on screen depths, well construction, subsurface geology, and other factors to evaluate whether lowering the water level in the artesian aquifer could affect nearby wells or surface water features. This type of evaluation was not included in the scope of this study.

Respectfully Submitted,

NTH Consultants, Ltd.



Joseph B. Alberts, P.E.

Project Manager



Alan C. Erickson, P.E.

Senior Project Engineer

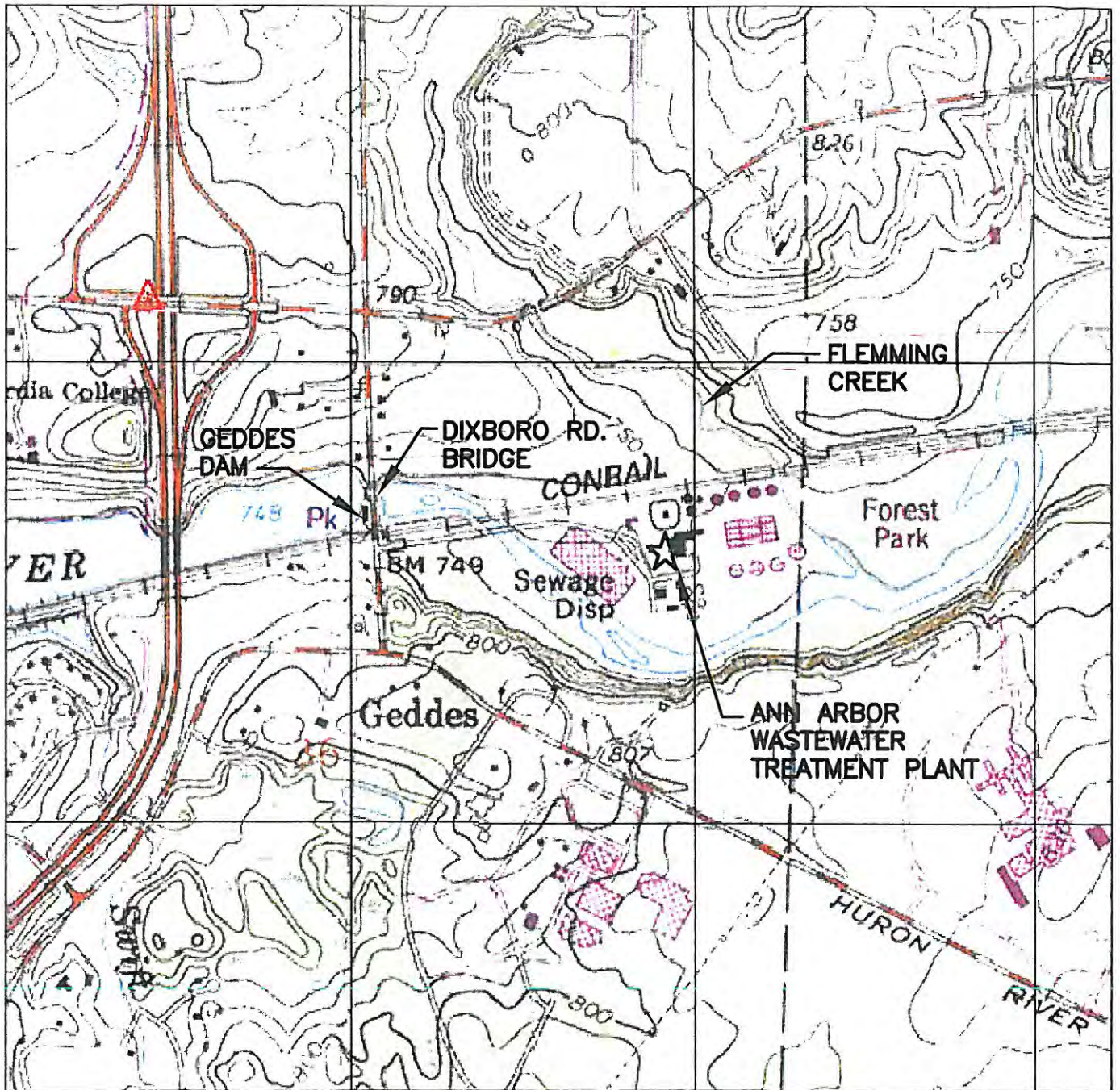
JBA/ACE/nf



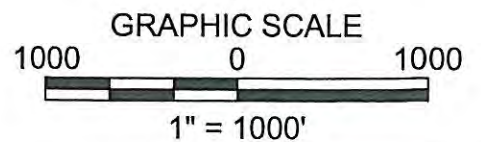
APPENDIX A


MAPS & SITE PLANS:

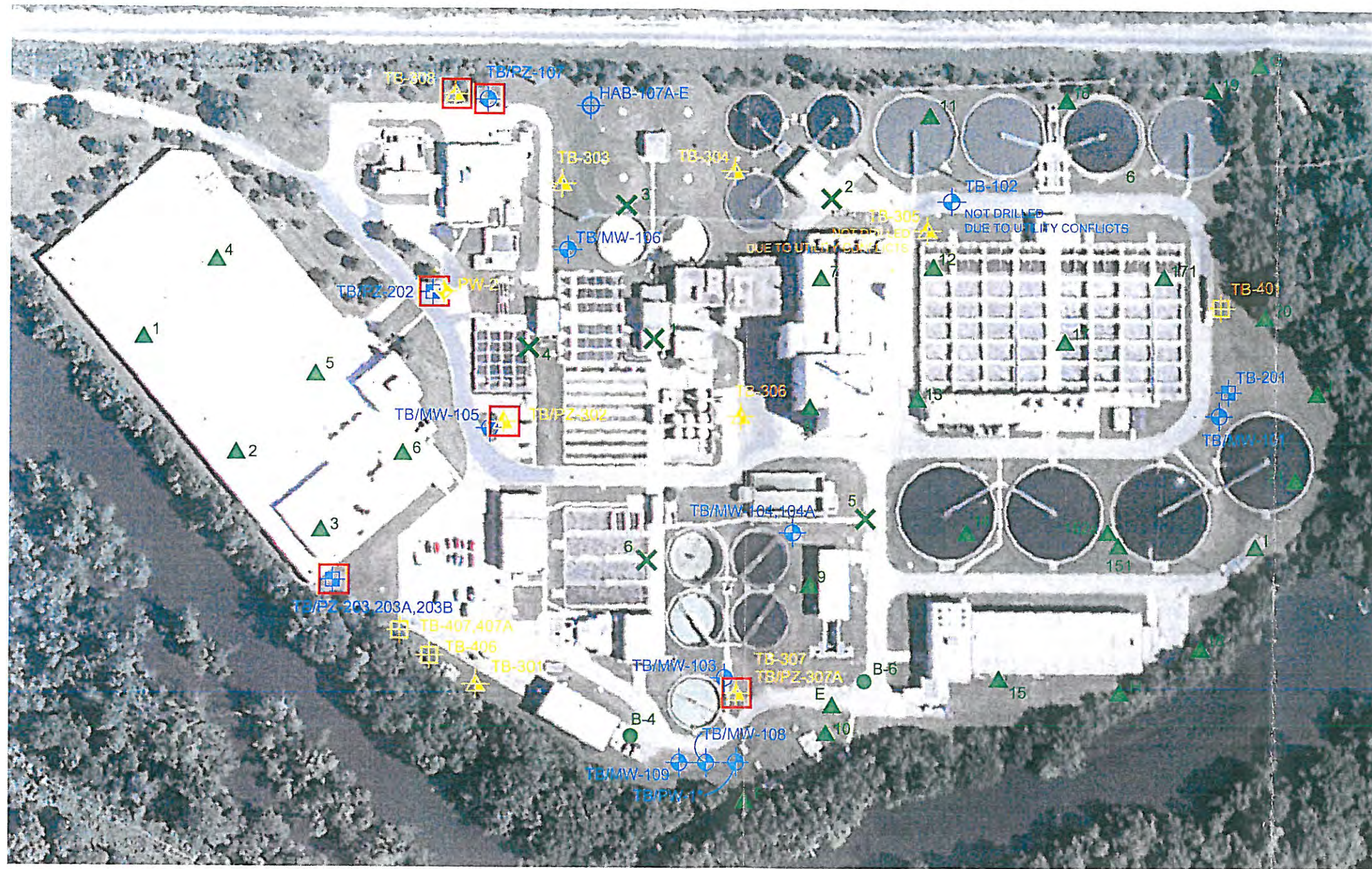
- **FIGURE 1: SITE LOCATION MAP**
- **FIGURE 2: TEST BORING LOCATION PLAN**
- **FIGURE 3: PUMPING TEST DRAWDOWN CONTOUR**
- **FIGURE 4: ESTIMATED THEORETICAL ZONE OF INFLUENCE**



SITE LOCATION MAP



NTH PROJECT No: 15-050510-06	CAD FILE NAME: 15/050510061	 NTH Consultants, Ltd. Infrastructure Engineering and Environmental Services	SITE LOCATION MAP	FIGURE: 1
DESIGNED BY: DLP	PLOT DATE: 09/27/06			
DRAWN BY: VR	DRAWING SCALE: AS SHOWN			
CHECKED BY:	INCEPTION DATE: 09/27/06			



LEGEND

- 1935 BORINGS (APPROXIMATE)
- 1997 TOL TEST BORINGS - LOCATIONS UNCERTAIN
- FAIRLANE BORINGS - 1977
- HAND AUGER BORING DRILLED BY NTH CONSULTANTS, LTD ON MAY 16, 2005

- TEST BORING DRILLED BY AMERICAN DRILLING & TESTING CO., INC. UNDER THE SUPERVISION OF NTH CONSULTANTS, LTD. MAY 16 THROUGH MAY 25, 2005 (100 SERIES BORINGS)
- TEST BORING DRILLED BY AMERICAN DRILLING & TESTING CO., INC. UNDER THE SUPERVISION OF NTH CONSULTANTS, LTD. AUGUST 22 THROUGH AUGUST 30, 2005 (200 SERIES BORINGS)

- TEST BORING DRILLED BY AMERICAN DRILLING & TESTING CO., INC. UNDER THE SUPERVISION OF NTH CONSULTANTS, LTD. JULY 18 THROUGH AUGUST 9, 2006 (300 SERIES BORINGS)
- TEST BORING DRILLED BY AMERICAN DRILLING & TESTING CO., INC. UNDER THE SUPERVISION OF NTH CONSULTANTS, LTD. ON AUGUST 10, 2006 (400 SERIES BORINGS)

- TEST WELL DRILLED BY RAYMER COMPANY, INC. UNDER THE SUPERVISION OF NTH CONSULTANTS, LTD. AUGUST 21 THROUGH AUGUST 29, 2006 (ARTESIAN PUMP TEST WELL)
- ARTESIAN GROUNDWATER ENCOUNTERED

* PW-1 NOT USED AS A PUMPING WELL DUE TO IN-SITU FIELD CONDITIONS

PZ DENOTES THAT PNEUMATIC PIEZOMETER WAS INSTALLED.

MW DENOTES MONITORING WELL WAS INSTALLED.

NTH Consultants, Ltd.
 Infrastructure Engineering
 and Environmental Services



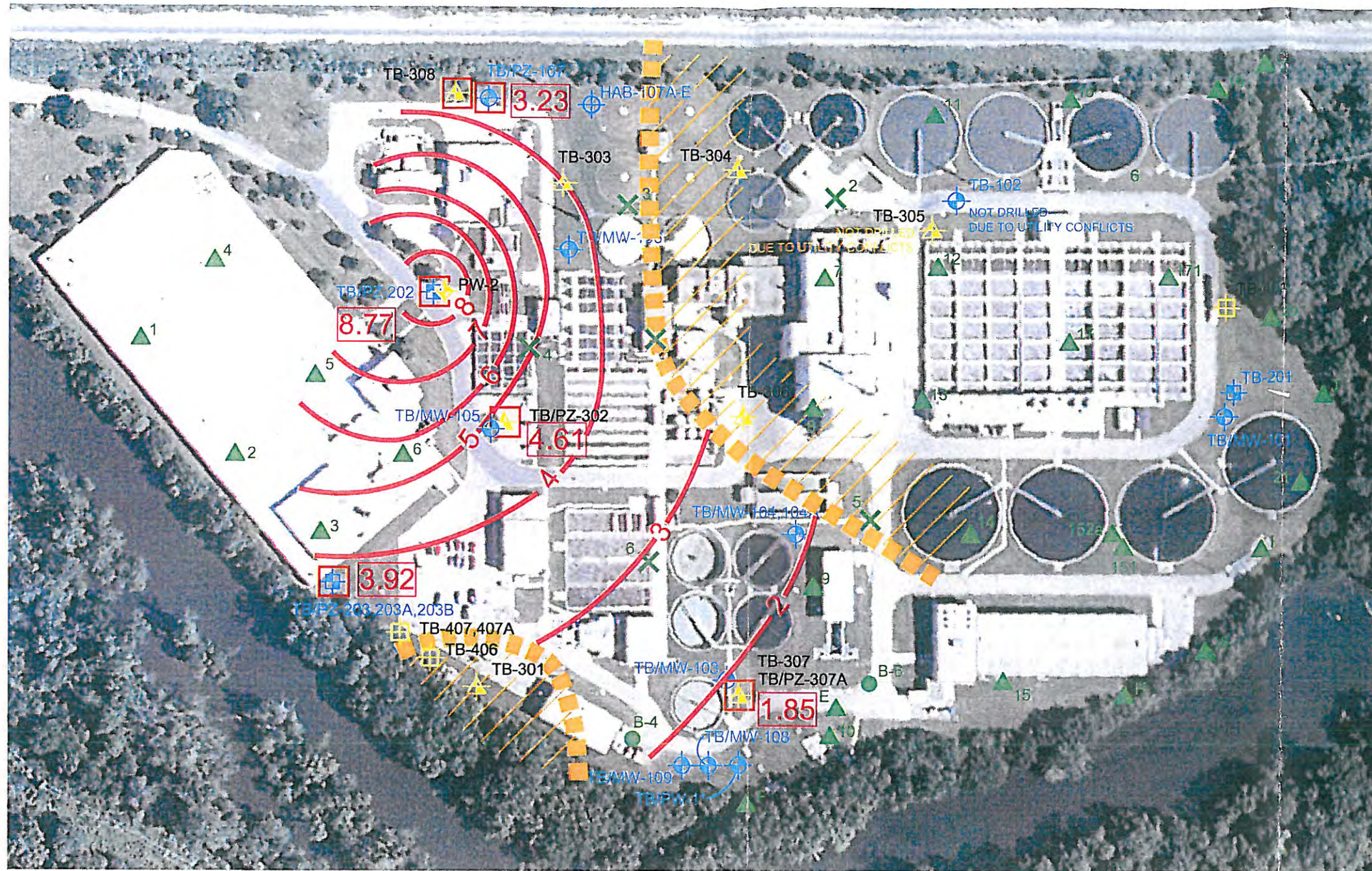
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DESIGNED BY: CRJ	INSEP DATE: 03 JUN 2005
DRAWN BY: SHB	DRAWING SCALE: 1" = 100'
CHECKED BY: JBA	PLOT DATE: 14 SEP 2006

TEST BORING LOCATION PLAN


















**ANN ARBOR WASTEWATER TREATMENT PLANT
 ANN ARBOR, MICHIGAN**

FIGURE:

2



LEGEND

-  1935 BORINGS (APPROXIMATE)
-  1997 TOL TEST BORINGS - LOCATIONS UNCERTAIN
-  FAIRLANE BORINGS - 1977
-  HAND AUGER BORING DRILLED BY NTH CONSULTANTS, LTD ON MAY 16, 2005
-  TEST BORING DRILLED BY AMERICAN DRILLING & TESTING CO., INC. UNDER THE SUPERVISION OF NTH CONSULTANTS, LTD. MAY 16 THROUGH MAY 25, 2005 (100 SERIES BORINGS)
-  TEST BORING DRILLED BY AMERICAN DRILLING & TESTING CO., INC. UNDER THE SUPERVISION OF NTH CONSULTANTS, LTD. AUGUST 22 THROUGH AUGUST 30, 2005 (200 SERIES BORINGS)
-  TEST BORING DRILLED BY AMERICAN DRILLING & TESTING CO., INC. UNDER THE SUPERVISION OF NTH CONSULTANTS, LTD. JULY 18 THROUGH AUGUST 9, 2006 (300 SERIES BORINGS)
-  TEST BORING DRILLED BY AMERICAN DRILLING & TESTING CO., INC. UNDER THE SUPERVISION OF NTH CONSULTANTS, LTD. ON AUGUST 10, 2006 (400 SERIES BORINGS)
-  TEST WELL DRILLED BY RAYMER COMPANY, INC. UNDER THE SUPERVISION OF NTH CONSULTANTS, LTD. AUGUST 21 THROUGH AUGUST 29, 2006 (ARTESIAN PUMP TEST WELL)
-  ARTESIAN GROUNDWATER ENCOUNTERED
-  SUSPECTED LIMITS OF CONFINED ARTESIAN ZONE BASED ON TEST BORING LOCATIONS WHERE DEEP GRANULAR ZONE WAS NOT PRESENT OR ARTESIAN CONDITIONS WERE NOT OBSERVED.
-  CONTOUR LINE OF EQUAL DRAWDOWN (FT) BASED ON OBSERVED POINTS
-  DRAWDOWN (FT) BELOW STATIC PIEZOMETRIC LEVEL OBSERVED AT PNEUMATIC PIEZOMETER AT CONCLUSION OF 24.5 -HR PUMPING TEST ON 9-8-06.
-  CONTOUR LINE OF EQUAL DRAWDOWN (FT) BASED ON OBSERVED POINTS
-  * PW-1 NOT USED AS A PUMPING WELL DUE TO IN-SITU FIELD CONDITIONS
-  PZ DENOTES THAT PNEUMATIC PIEZOMETER WAS INSTALLED.
-  MW DENOTES MONITORING WELL WAS INSTALLED.

NTH Consultants, Ltd.
Infrastructure Engineering
and Environmental Services

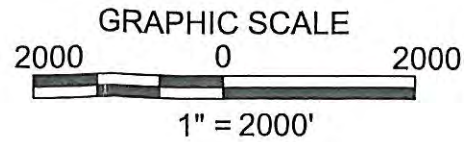
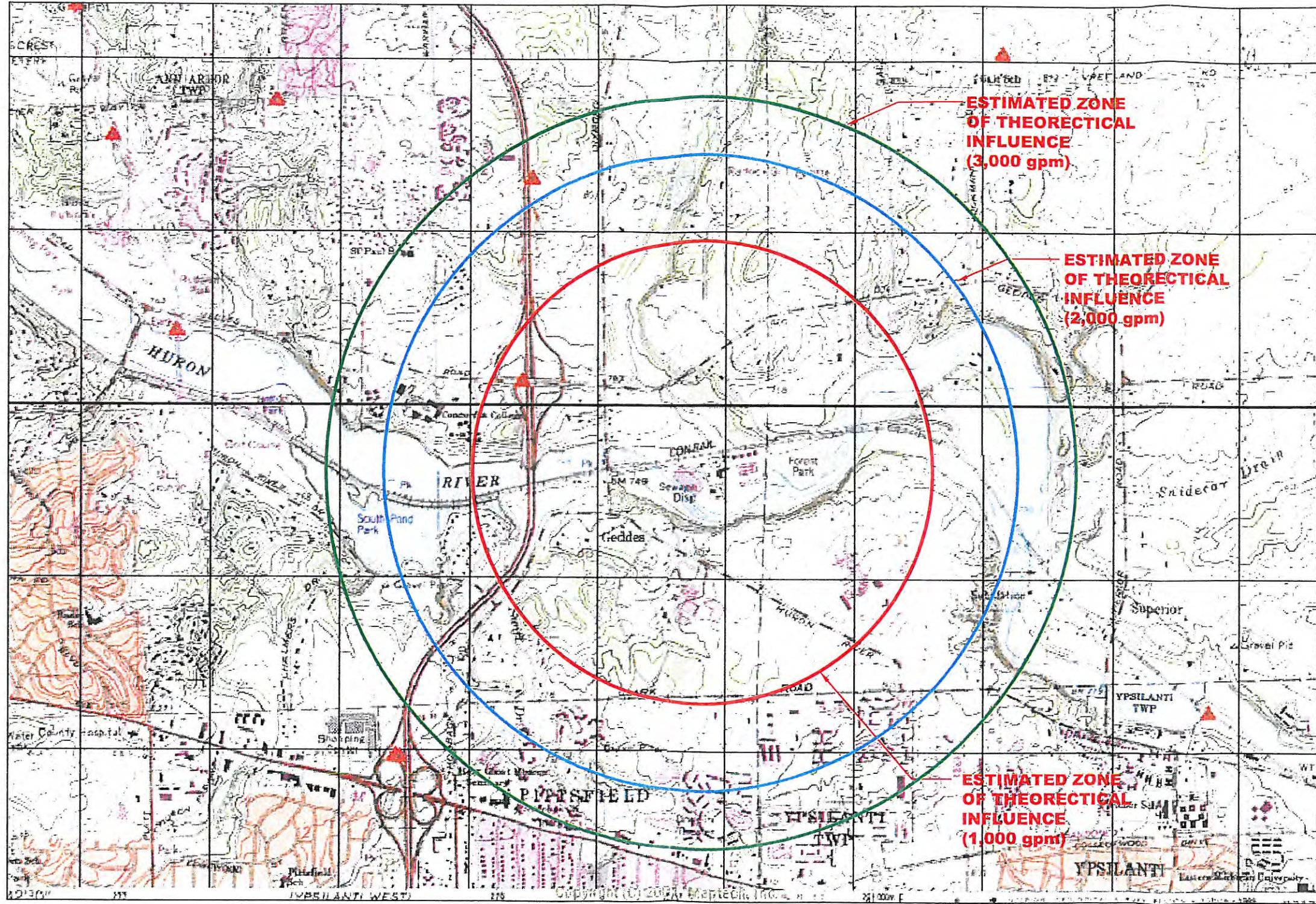



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DESIGNED BY:	CRJ	INCEP DATE:	03 JUN 2005
DRAWN BY:	SHB	DRAWING SCALE:	1" = 100'
CHECKED BY:		PLOT DATE:	10-27-06

PUMPING TEST DRAWDOWN COUNTOUR
ANN ARBOR WASTEWATER TREATMENT PLANT
ANN ARBOR, MICHIGAN

FIGURE:
3

J:\15\050510064.dwg
10-27-06



 <p>NTH Consultants, Ltd. Infrastructure Engineering and Environmental Services</p>	
<p>NTH PROJECT NO.: 15-050510-06</p> <p>DESIGNED BY: ACE</p> <p>DRAWN BY: JD</p> <p>CHECKED BY:</p>	<p>CAD FILE NAME: J:\15\050510064.dwg</p> <p>PLOT DATE: 10-27-06</p> <p>DRAWING SCALE: AS SHOWN</p> <p>INCEPTION DATE:</p>
<p>ESTIMATED THEORETICAL ZONE OF INFLUENCE</p> <p>ANN ARBOR WASTEWATER TREAT PLANT ANN ARBOR, MICHIGAN</p>	
<p>FIGURE:</p> <p style="font-size: 2em; font-weight: bold;">4</p>	



APPENDIX B

WELL LOGS (FIGURES 5 – 24):

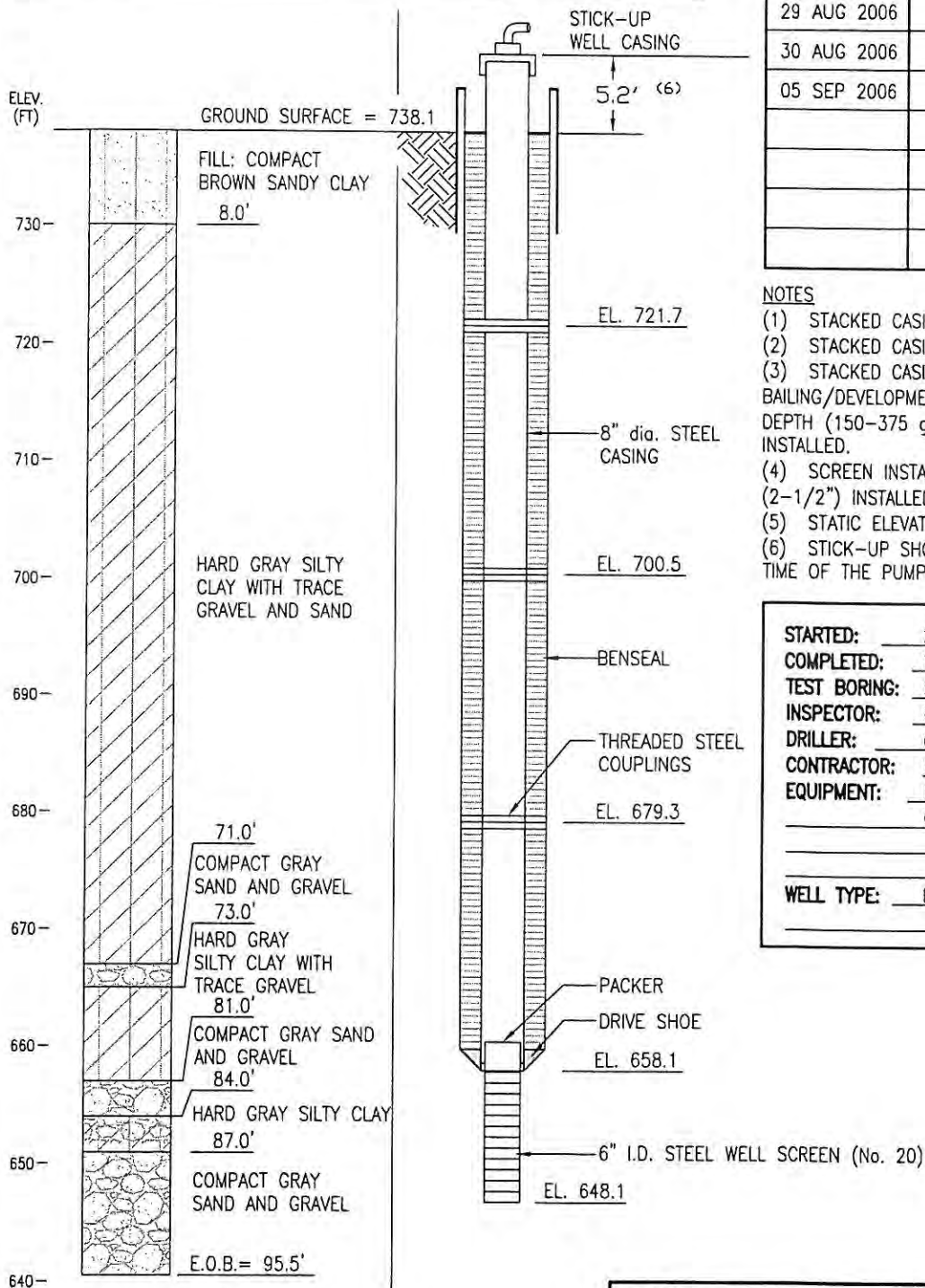
- **TEST WELL (PW-2) LOG**
- **GRAIN SIZE DISTRIBUTION CURVE & WELL SCREEN DESIGN**
- **LOG OF WELL ABANDONMENT (PW-2)**
- **PNEUMATIC PIEZOMETER LOGS**
- **PNEUMATIC PIEZOMETER DESCRIPTION DATA SHEET**
- **SHALLOW MONITORING WELL LOGS**
- **LOGS OF HISTORIC WATER SUPPLY WELLS AT A.A. SEWAGE TREATMENT PLANT**

LOG PUMPING WELL No. PW-2

**CLASSIFIED BY:
NTH CONSULTANTS, LTD.**

**GENERALIZED
SUBSURFACE PROFILE**

SCHEMATIC




DATE	ELEVATION (FEET)
21 AUG 2006	750.6 (1)
28 AUG 2006	750.6 (2)
29 AUG 2006	755.6 (3)
30 AUG 2006	-- (4)
05 SEP 2006	756.8 (5)

NOTES

- (1) STACKED CASING OVERNIGHT
- (2) STACKED CASING OVERNIGHT
- (3) STACKED CASING OVERNIGHT AFTER BAILING/DEVELOPMENT OF 81 TO 84 FOOT DEPTH (150-375 gpm). SCREEN WAS NOT INSTALLED.
- (4) SCREEN INSTALLED. BALL VALVE (2-1/2") INSTALLED TO CONTROL FLOW.
- (5) STATIC ELEVATION FROM STACKED CASING
- (6) STICK-UP SHOWN WAS MEASURED AT THE TIME OF THE PUMP TEST.

STARTED:	21 AUG 2006
COMPLETED:	29 AUG 2006
TEST BORING:	SAMPLED WHILE DRILLING
INSPECTOR:	C. JOHNSON
DRILLER:	C. BRECKEN
CONTRACTOR:	RAYMER COMPANY, INC.
EQUIPMENT:	BUCYRUS ERIE 22W CABLE TOOL DRILL RIG
WELL TYPE:	PUMPING WELL

D050510PW2 12 SEP 2006

 NTH CONSULTANTS, LTD. Professional Engineering & Environmental Services Detroit, Michigan			
MONITORING WELL No. PW-2			
ANN ARBOR WASTEWATER TREATMENT PLANT IMPROVEMENTS ANN ARBOR, MICHIGAN			
PROJECT NO. 15-050510-06	DRAWN BY: SHB	DATE: 12 SEP 2006	FIGURE NO. 5
SCALE: NONE	CHECKED BY: CRJ	SHEET 1 of 1	

J P.O. Box 64118 • St. Paul, MN 55164
 TEL. 612-636-3900 or 1-800-328-9891
 TELEX 29-7451
 SEND SAMPLES TO: 1950 OLD HWY 8, NEW BRIGHTON, MN 55112

NO. 797 P. 2
SAND ANALYSIS

BY: *E.J.N.*

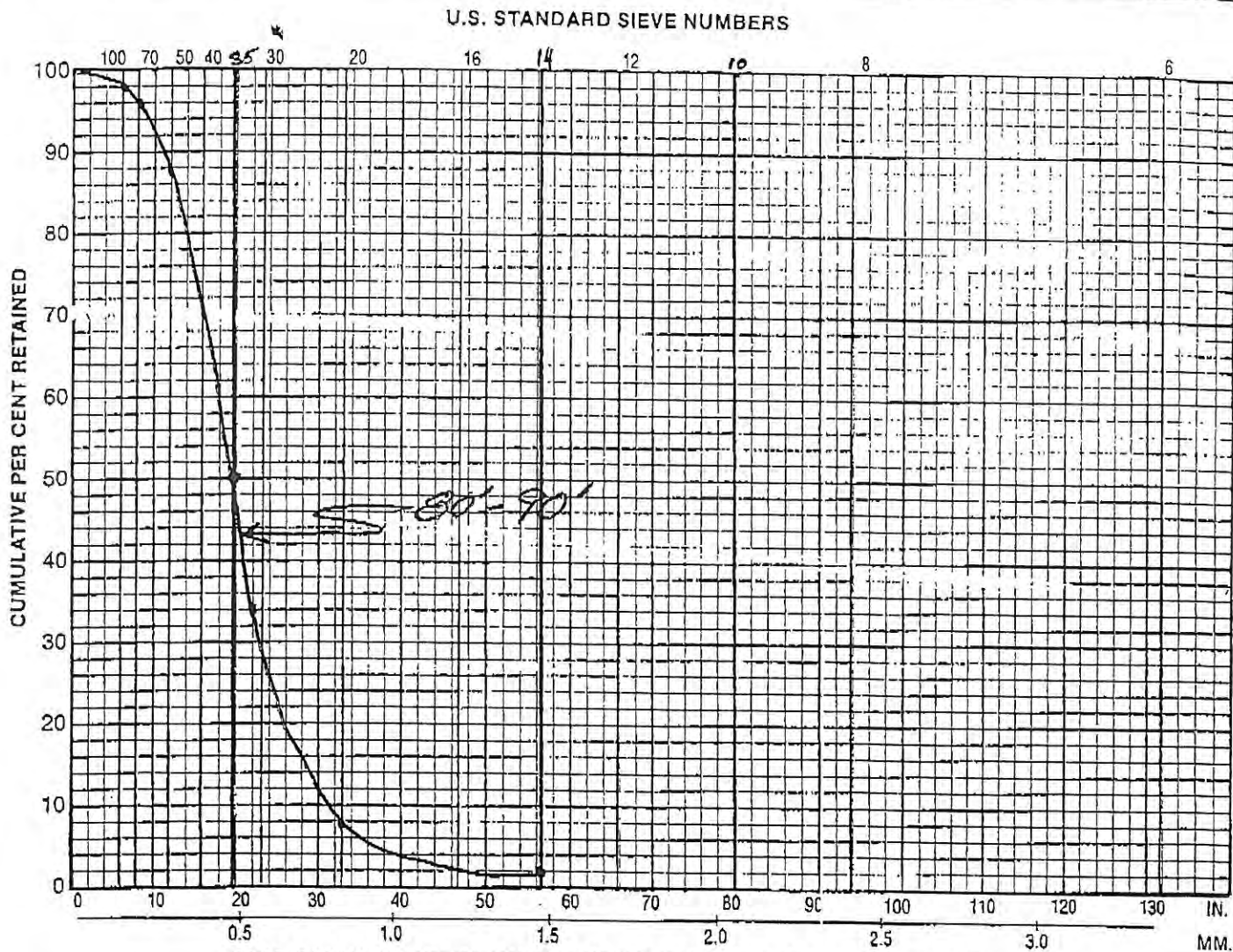
Job Name *Ann Arbor WWTP* Date *Aug 31, 2006*

City _____ State _____ Zip _____

Driller *Raymer* Phone _____

Engineer *NTH* Phone _____

Remarks _____



U.S. SIEVE NO.	SLOT OPENING		SAMPLE DEPTHS
	IN.	MM	
6	.132	3.36	—
8	.094	2.38	—
10			—
14			2%
20	.033	0.84	13%
30	.023	0.60	34%
35			50%
50	.012	0.30	88%
70	.008	0.21	96%
100	.006	0.15	98%
200			100%

Comments _____

SCREEN RECOMMENDATIONS: DIAM. _____

SLOT	SETTING	LENGTH
<i>.020"</i>	<i>80'-90'</i>	<i>10'</i>

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF ANY WELL.

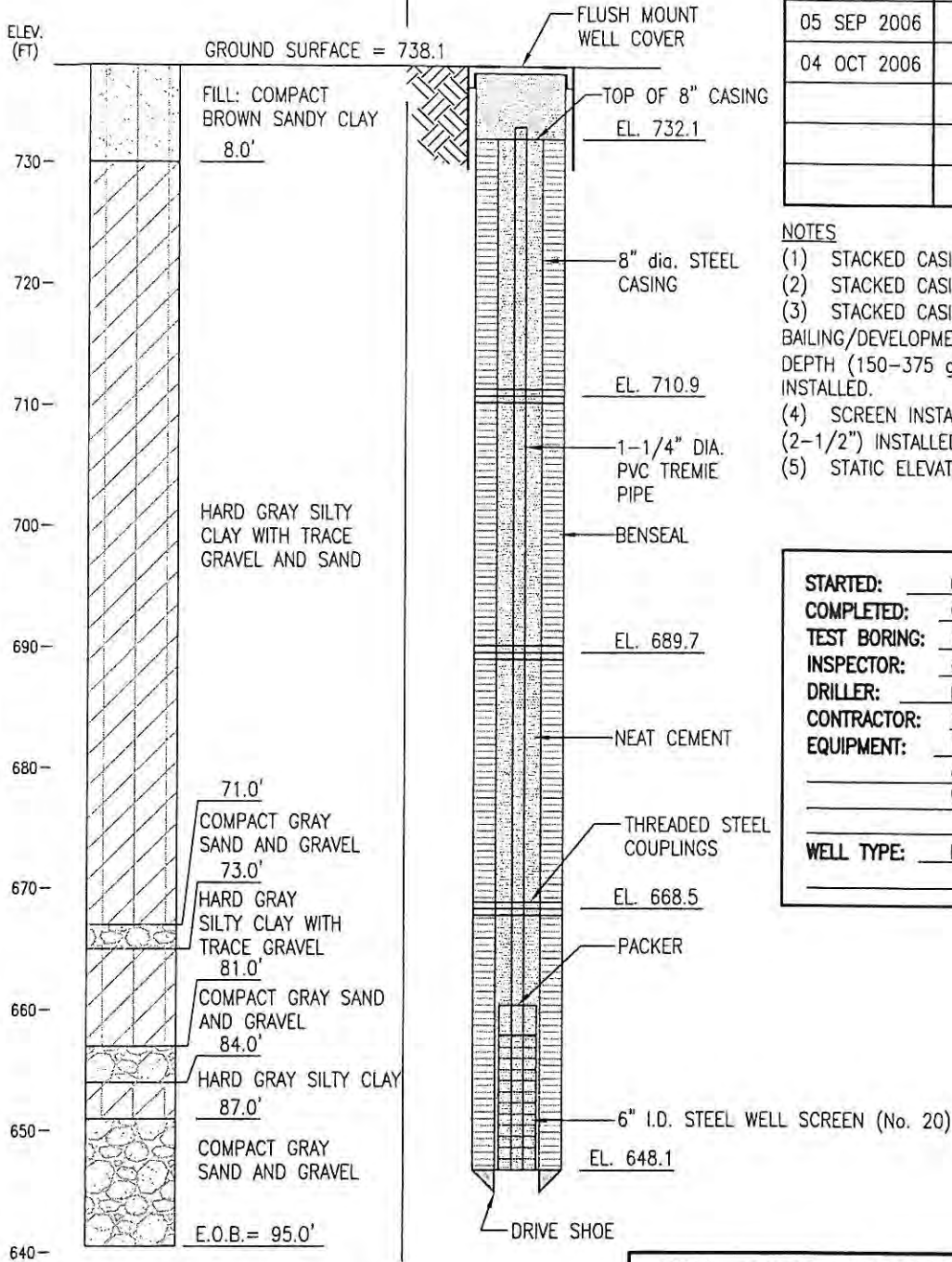
FIGURE 5A

LOG PUMPING WELL No. PW-2 (ABANDONMENT)

**CLASSIFIED BY:
NTH CONSULTANTS, LTD.**

**GENERALIZED
SUBSURFACE PROFILE**

SCHEMATIC



DATE	ELEVATION (FEET)
21 AUG 2006	750.6 (1)
28 AUG 2006	750.6 (2)
29 AUG 2006	755.6 (3)
30 AUG 2006	-- (4)
05 SEP 2006	756.8 (5)
04 OCT 2006	ABANDONED

NOTES

- (1) STACKED CASING OVERNIGHT
- (2) STACKED CASING OVERNIGHT
- (3) STACKED CASING OVERNIGHT AFTER BAILING/DEVELOPMENT OF 81 TO 84 FOOT DEPTH (150-375 gpm). SCREEN WAS NOT INSTALLED.
- (4) SCREEN INSTALLED. BALL VALVE (2-1/2") INSTALLED TO CONTROL FLOW.
- (5) STATIC ELEVATION FROM STACKED CASING

STARTED:	04 OCT 2006
COMPLETED:	04 OCT 2006
TEST BORING:	N/A
INSPECTOR:	C. JOHNSON
DRILLER:	K. BURNS
CONTRACTOR:	RAYMER COMPANY, INC.
EQUIPMENT:	DOUBLE BARREL GROUT PUMP WITH PVC TREMIE PIPE
WELL TYPE:	PUMPING WELL

D050510PW2ABAND 10 OCT 2006



NTH CONSULTANTS, LTD.

Professional Engineering & Environmental Services
Detroit, Michigan

MONITORING WELL No. PW-2 (ABANDONED)

**ANN ARBOR WASTEWATER TREATMENT PLANT IMPROVEMENTS
ANN ARBOR, MICHIGAN**

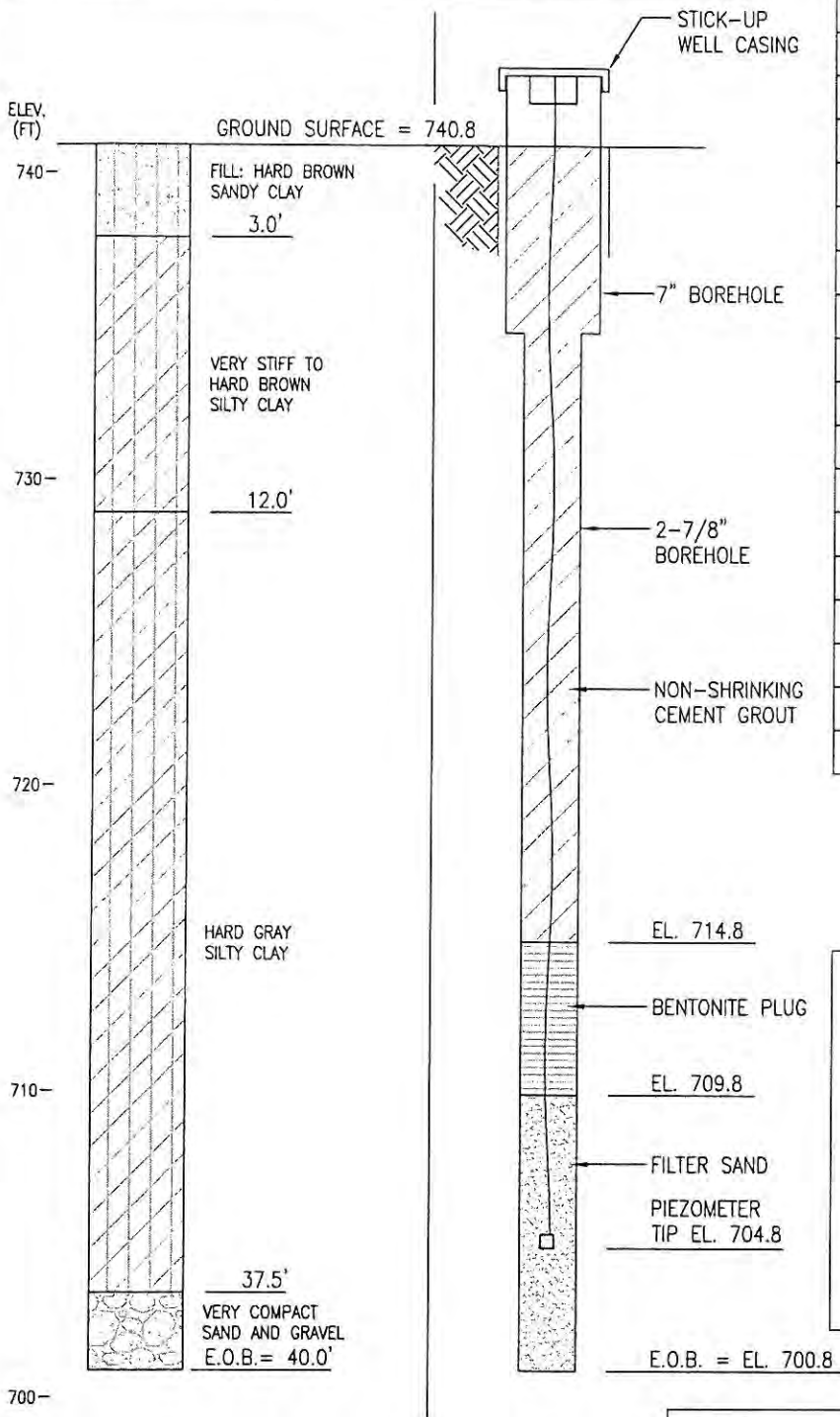
PROJECT NO. 15-050510-06	DRAWN BY: SHB	DATE: 10 OCT 2006	FIGURE NO. 6
SCALE: NONE	CHECKED BY: CRJ	SHEET 1 OF 1	

LOG PNEUMATIC PIEZOMETER PZ-107

CLASSIFIED BY:
NTH CONSULTANTS, LTD.

GENERALIZED
SUBSURFACE PROFILE


SCHEMATIC



DATE	ELEVATION (FEET)
18 MAY 2005	757.9 (23 psi)
24 MAY 2005	757.9 (23 psi)
25 MAY 2005	757.9 (23 psi)
10 JUN 2005	757.9 (23 psi)
26 JUL 2005	756.2 (22.25 psi)
22 AUG 2005	756.2 (22.25 psi)
02 SEP 2005	756.2 (22.25 psi)
12 SEP 2005	756.2 (22.25 psi)
20 SEP 2005	756.2 (22.25 psi)
10 OCT 2005	756.2 (22.25 psi)
20 OCT 2005	756.2 (22.25 psi)
21 NOV 2005	756.7 (22.5 psi)
26 MAY 2006	758.5 (23.25 psi)
29 JUN 2006	759.0 (23.5 psi)
07 AUG 2006	757.3 (22.75 psi)
10 AUG 2006	756.7 (22.5 psi)
06 SEP 2006	756.5 (22.4 psi)
07 SEP 2006	756.0 (22.2 psi)
11 SEP 2006	757.4 (22.8 psi)
19 SEP 2006	756.7 (22.5 psi)

STARTED:	17 MAY 2005
COMPLETED:	18 MAY 2005
TEST BORING:	TB-107
INSPECTOR:	C. JOHNSON
DRILLER:	J. BLANK
CONTRACTOR:	AMERICAN DRILLING
EQUIPMENT:	CME 75 DRILL RIG
WELL TYPE:	PNEUMATIC PIEZOMETER

D050510PZ107 12 SEP 2006

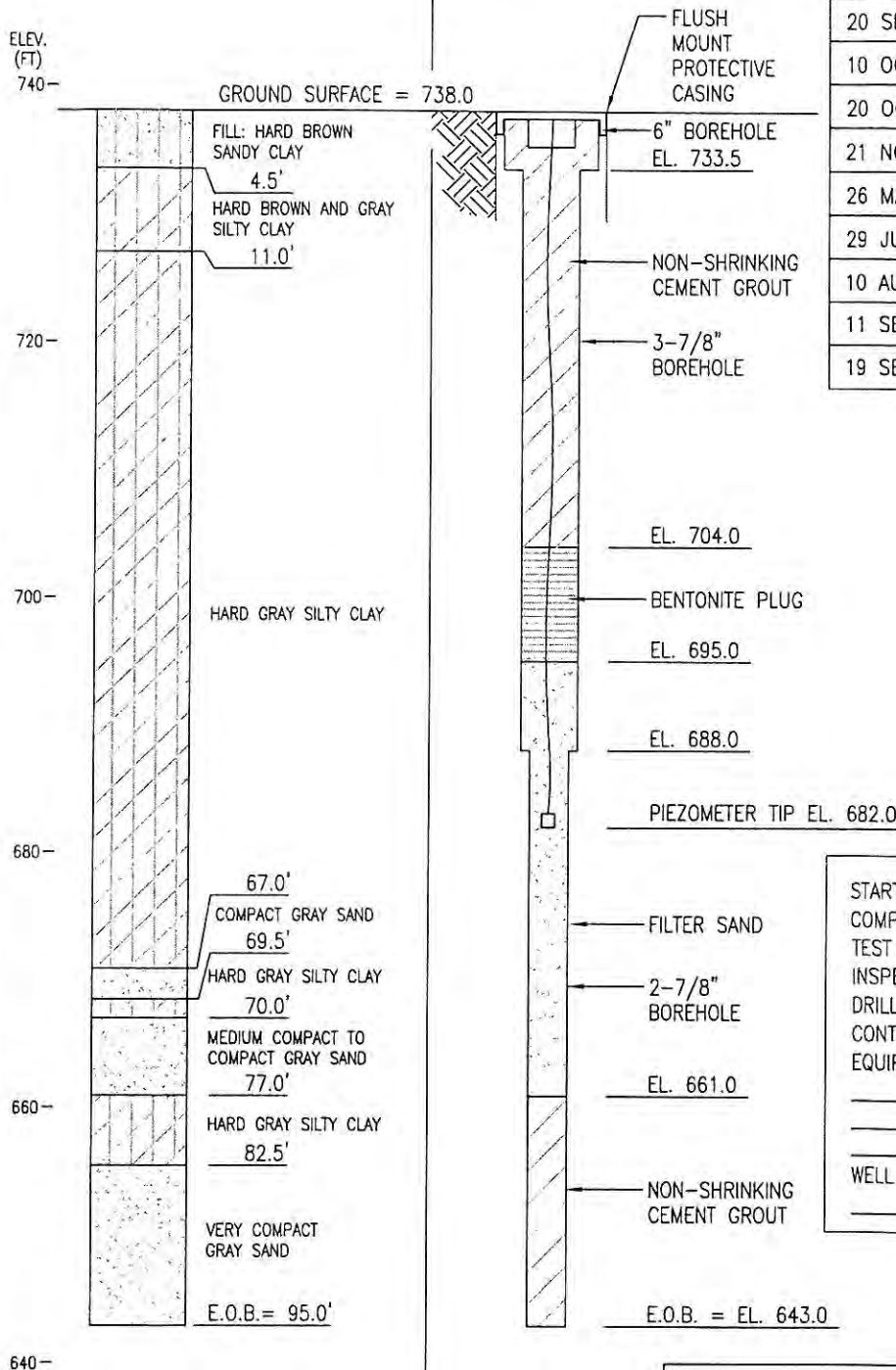
 NTH CONSULTANTS, LTD. Professional Engineering & Environmental Services Detroit, Michigan			
PIEZOMETER No. PZ-107			
ANN ARBOR WASTEWATER TREATMENT PLANT IMPROVEMENTS ANN ARBOR, MICHIGAN			
PROJECT NO. 15-050510-00	DRAWN BY: SHB	DATE: 12 SEP 2006	FIGURE NO.
SCALE: NONE	CHECKED BY: CRJ	SHEET 1 OF 1	7

LOG PNEUMATIC PIEZOMETER PZ-202

CLASSIFIED BY:
NTH CONSULTANTS, LTD.

GENERALIZED
SUBSURFACE PROFILE

SCHEMATIC



DATE	ELEVATION (FEET)
26 AUG 2005	754.7 (31.5 psi)
02 SEP 2005	754.7 (31.5 psi)
12 SEP 2005	754.7 (31.5 psi)
20 SEP 2005	754.7 (31.5 psi)
10 OCT 2005	754.7 (31.5 psi)
20 OCT 2005	754.7 (31.5 psi)
21 NOV 2005	754.7 (31.5 psi)
26 MAY 2006	756.4 (32.25 psi)
29 JUN 2006	755.9 (32.0 psi)
10 AUG 2006	755.9 (32.0 psi)
11 SEP 2006	754.5 (31.4 psi)
19 SEP 2006	754.7 (31.5 psi)

STARTED:	23 AUG 2005
COMPLETED:	26 AUG 2005
TEST BORING:	TB-202
INSPECTOR:	C. JOHNSON
DRILLER:	J. BLANK
CONTRACTOR:	AMERICAN DRILLING
EQUIPMENT:	CME 75 DRILL RIG
WELL TYPE:	PNEUMATIC PIEZOMETER

D050510PZ202 12 SEP 2006



NTH CONSULTANTS, LTD.
Professional Engineering & Environmental Services
Detroit, Michigan

PIEZOMETER No. PZ-202

ANN ARBOR WASTEWATER TREATMENT PLANT IMPROVEMENTS
ANN ARBOR, MICHIGAN

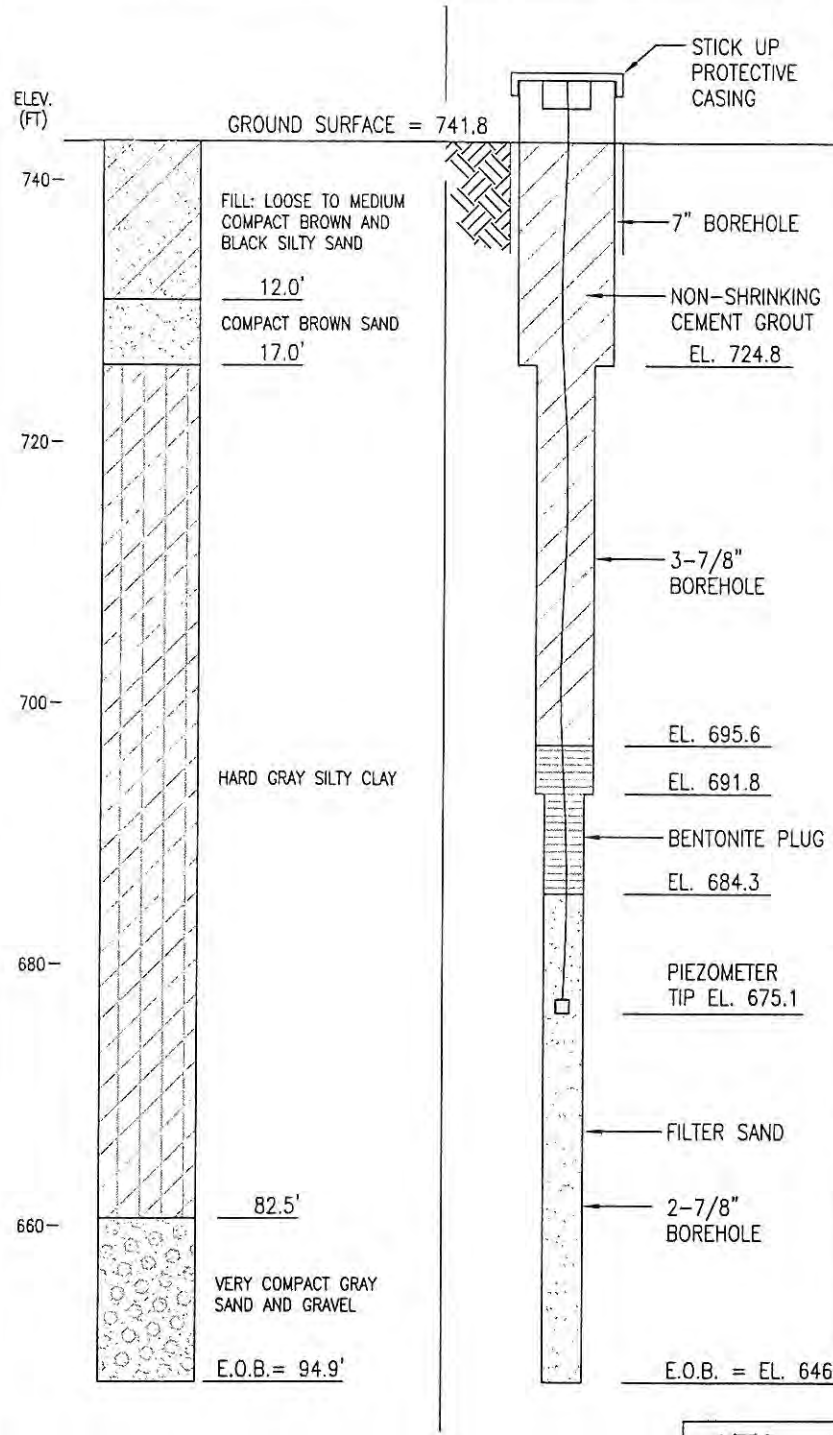
PROJECT NO. 15-050510-01	DRAWN BY: SHB	DATE: 12 SEP 2006	FIGURE NO. 8
SCALE: NONE	CHECKED BY: CRJ	SHEET 1 OF 1	

LOG PNEUMATIC PIEZOMETER PZ-203

CLASSIFIED BY:
NTH CONSULTANTS, LTD.

GENERALIZED SUBSURFACE PROFILE	SCHEMATIC
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DATE	ELEVATION (FEET)
30 AUG 2005	757.0 (35.5 psi)
02 SEP 2005	757.0 (35.5 psi)
12 SEP 2005	757.0 (35.5 psi)
20 SEP 2005	757.2 (35.5 psi)
10 OCT 2005	757.2 (35.5 psi)
20 OCT 2005	757.2 (35.5 psi)
21 NOV 2005	756.4 (35.25 psi)
26 MAY 2006	759.3 (36.5 psi)
29 JUN 2006	760.5 (37.0 psi)
01 AUG 2006	766.2 (39.5 psi)
10 AUG 2006	766.2 (39.5 psi)
07 SEP 2006	757.0 (35.5 psi)
11 SEP 2006	757.7 (35.8 psi)
19 SEP 2006	757.6 (35.8 psi)



STARTED: 26 AUG 2005
 COMPLETED: 30 AUG 2005
 TEST BORING: TB-203B
 INSPECTOR: C. JOHNSON
 DRILLER: J. BLANK
 CONTRACTOR: AMERICAN DRILLING
 EQUIPMENT: CME 75 DRILL RIG

WELL TYPE: PNEUMATIC PIEZOMETER

D050510PZ203 12 SEP 2006

NTH CONSULTANTS, LTD.
 Professional Engineering & Environmental Services
 Detroit, Michigan

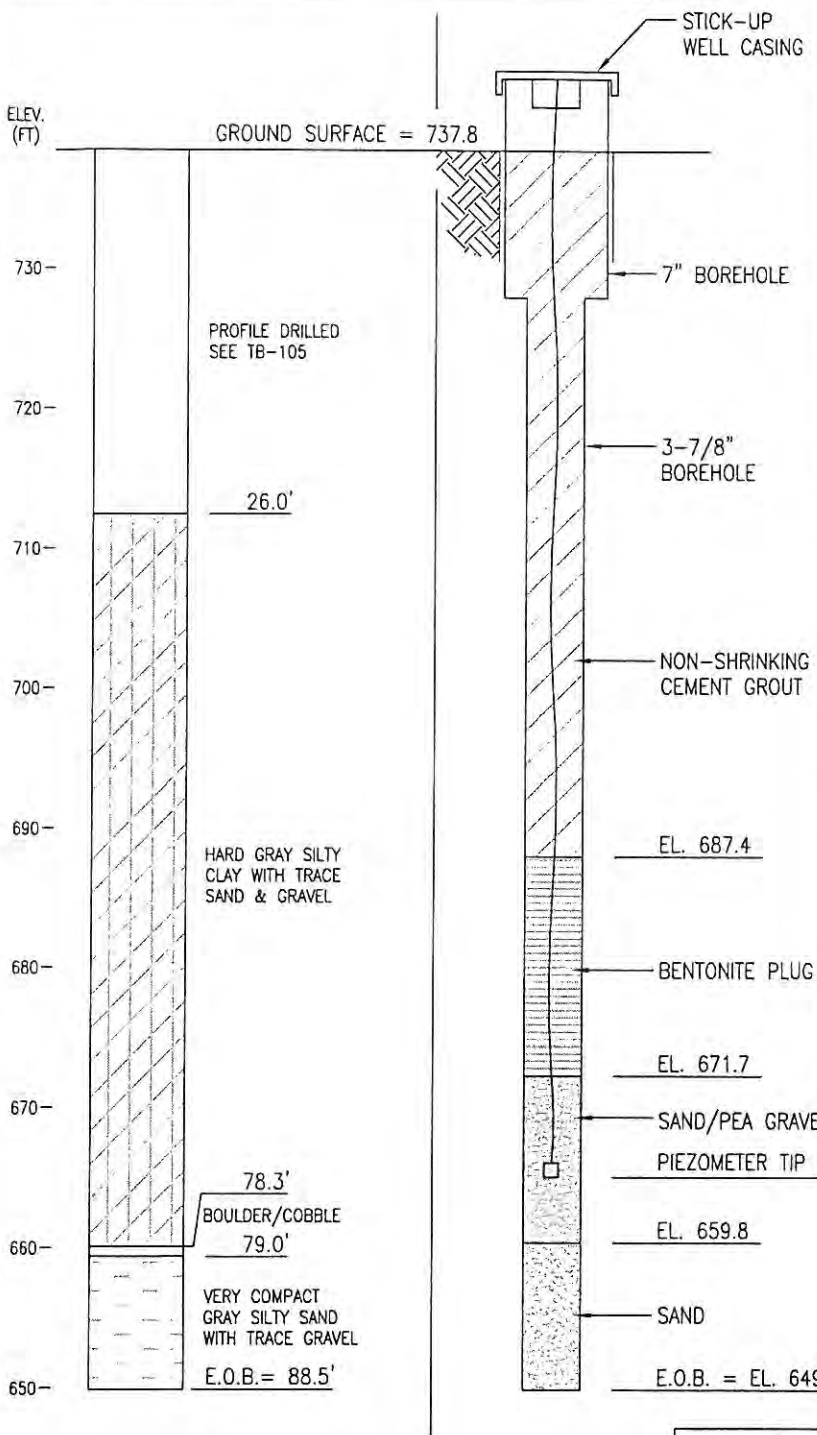
PIEZOMETER No. PZ-203

ANN ARBOR WASTEWATER TREATMENT PLANT IMPROVEMENTS
 ANN ARBOR, MICHIGAN

PROJECT NO. 15-050510-01	DRAWN BY: SHB	DATE: 12 SEP 2006	FIGURE NO. 9
SCALE: NONE	CHECKED BY: CRJ	SHEET 1 OF 1	

LOG PNEUMATIC PIEZOMETER PZ-302
 CLASSIFIED BY:
 NTH CONSULTANTS, LTD.
 GENERALIZED SUBSURFACE PROFILE SCHEMATIC

DATE	ELEVATION (FEET)
20 JUL 2006	753.9 (38.75 psi)
21 JUL 2006	755.7 (39.5 psi)
26 JUL 2006	755.7 (39.5 psi)
10 AUG 2006	755.7 (39.5 psi)
05 SEP 2006	755.7 (39.5 psi)
07 SEP 2006	754.5 (39.0 psi)
11 SEP 2006	755.4 (39.4 psi)



STARTED: 19 JUL 2006
 COMPLETED: 20 JUL 2006
 TEST BORING: TB-302
 INSPECTOR: S. GOLE
 DRILLER: J. BLANK
 CONTRACTOR: AMERICAN DRILLING
 EQUIPMENT: CME 75 DRILL RIG
 WELL TYPE: PNEUMATIC PIEZOMETER

D050510PZ302_12_SEP_2006

NTH CONSULTANTS, LTD.
 Professional Engineering & Environmental Services
 Detroit, Michigan

PIEZOMETER No. PZ-302

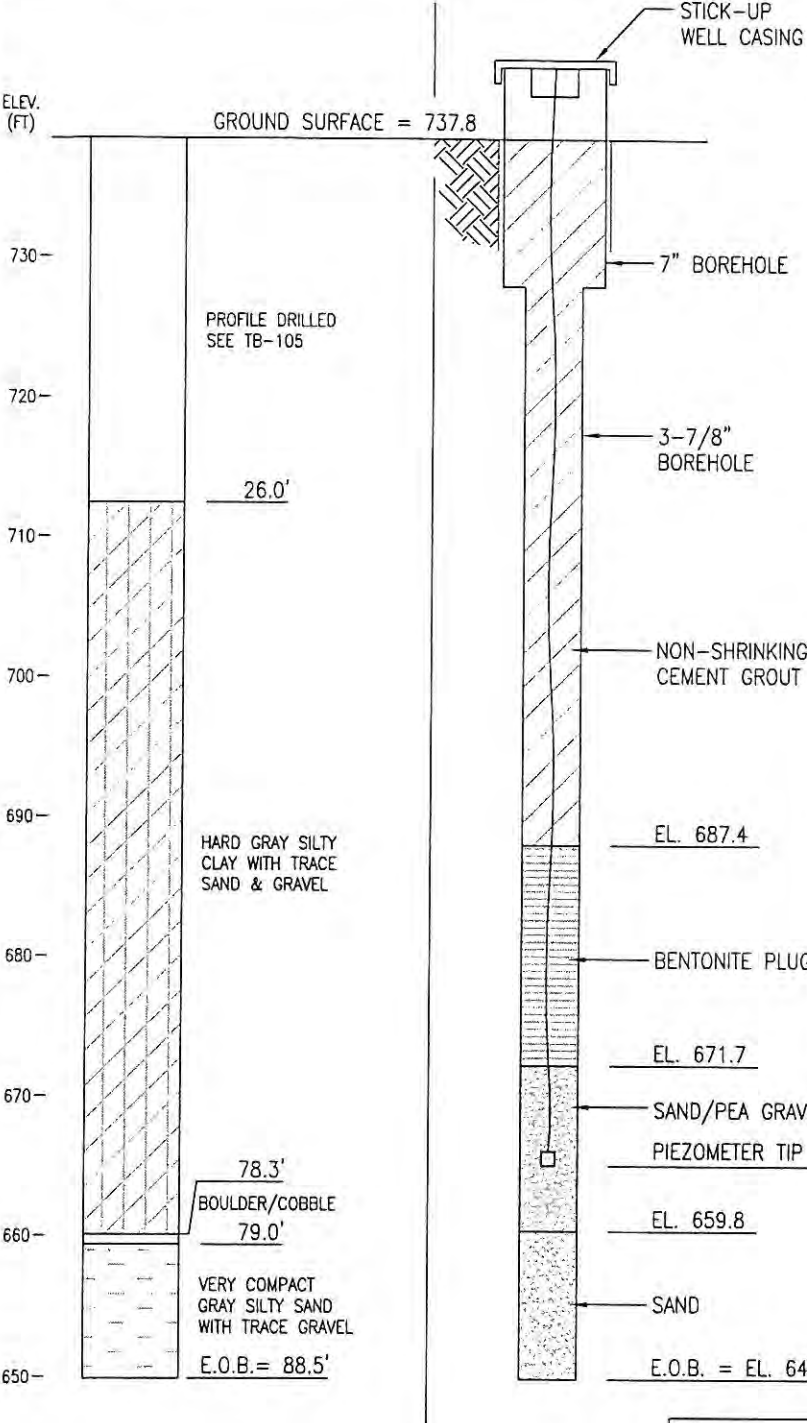
ANN ARBOR WASTEWATER TREATMENT PLANT IMPROVEMENTS
 ANN ARBOR, MICHIGAN

PROJECT NO. 15-050510-04	DRAWN BY: SHB	DATE: 12 SEP 2006	FIGURE NO. 10
SCALE: NONE	CHECKED BY: SGG	SHEET 1 OF 1	

LOG PNEUMATIC PIEZOMETER PZ-302
 CLASSIFIED BY:
 NTH CONSULTANTS, LTD.

GENERALIZED SUBSURFACE PROFILE	SCHEMATIC
-----------------------------------	-----------

DATE	ELEVATION (FEET)
20 JUL 2006	753.9 (38.75 psi)
21 JUL 2006	755.7 (39.5 psi)
26 JUL 2006	755.7 (39.5 psi)
10 AUG 2006	755.7 (39.5 psi)
05 SEP 2006	755.7 (39.5 psi)
07 SEP 2006	754.5 (39.0 psi)
11 SEP 2006	755.4 (39.4 psi)

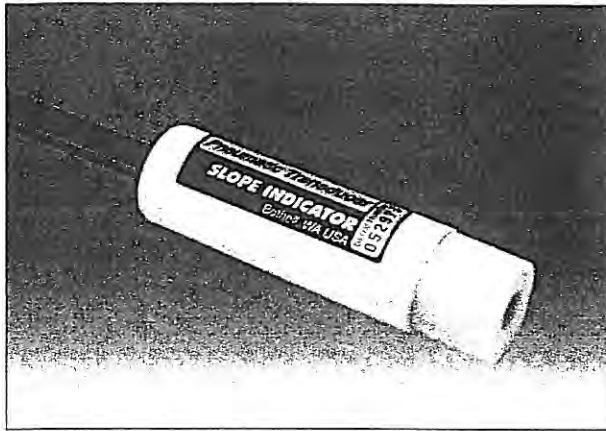


STARTED:	19 JUL 2006
COMPLETED:	20 JUL 2006
TEST BORING:	TB-302
INSPECTOR:	S. GOLE
DRILLER:	J. BLANK
CONTRACTOR:	AMERICAN DRILLING
EQUIPMENT:	CME 75 DRILL RIG
WELL TYPE:	PNEUMATIC PIEZOMETER

D050510PZ302 12 SEP 2006

NTH CONSULTANTS, LTD. Professional Engineering & Environmental Services Detroit, Michigan			
PIEZOMETER No. PZ-302			
ANN ARBOR WASTEWATER TREATMENT PLANT IMPROVEMENTS ANN ARBOR, MICHIGAN			
PROJECT NO. 15-050510-04	DRAWN BY: SHB	DATE: 12 SEP 2006	<div style="font-size: 2em; font-weight: bold;">11</div>
SCALE: NONE	CHECKED BY: SGG	SHEET 1 OF 1	

Pneumatic Piezometer



Applications

Pneumatic piezometers are used to measure pore water pressure in saturated soils. Applications include:

- Monitoring pore pressures to determine safe rates of fill or excavation.
- Monitoring pore water pressures to determine slope stability.
- Monitoring the effects of dewatering systems used for excavations.
- Monitoring the effects of ground improvement systems such as vertical drains and sand drains.
- Monitoring pore water pressures to check the performance of earth fill dams and embankments.
- Monitoring pore water pressures to check containment systems at land fills and tailings dams.

Advantages

Slope Indicator's pneumatic piezometers employ a simple and reliable transducer that is inherently free from drift.

Long term performance is enhanced by corrosion-resistant plastic construction, polyethylene tubing, and in-line filters in all connectors.

Twin-tube design is compatible with both "flow" and "no-flow" reading techniques.

Operating Principle

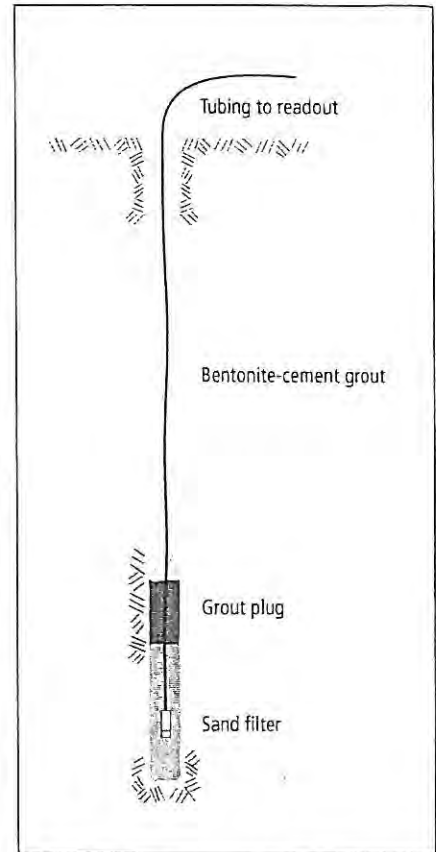
In a typical installation, the piezometer is sealed in a borehole, embedded in fill, or suspended in a standpipe. Twin pneumatic tubes run from the piezometer to a terminal at the surface. Readings are obtained with a pneumatic indicator.

The piezometer contains a flexible diaphragm. Water pressure acts on one side of the diaphragm and gas pressure acts on the other.

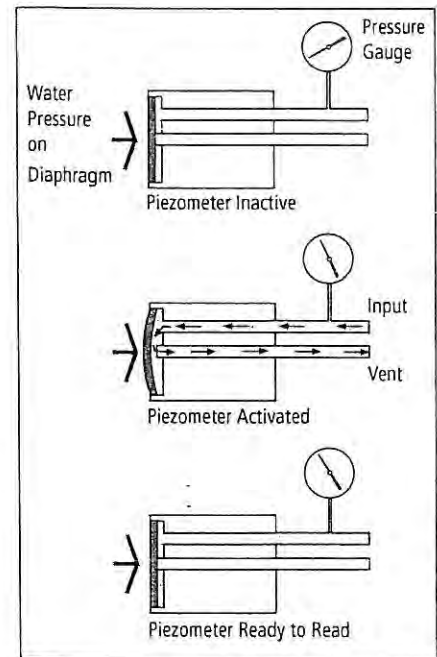
When a reading is required, a pneumatic indicator is connected to the terminal or directly to the tubing. Compressed nitrogen gas from the indicator flows down the input tube to increase gas pressure on the diaphragm. When gas pressure exceeds water pressure, the diaphragm is forced away from the vent tube, allowing excess gas to escape via the vent tube.

When the return flow of gas is detected at the surface, the gas supply is shut off. Gas pressure in the piezometer decreases until water pressure forces the diaphragm to its original position, preventing further escape of gas through the vent tube.

At this point, gas pressure equals water pressure, and a reading can be obtained from the pressure gauge on the indicator.



Typical Installation



Operating Principle

PNEUMATIC PIEZOMETER

Sensor Type: Twin-tube pneumatic transducer.
 Range: 12 bar, 180 psi with standard readout.
 Pressure rated for 27.5 bar or 400 psi.
 Resolution: 0.001 bar, 0.01 psi (digital gauge).
 Accuracy: $\pm 0.015\%$ FS (digital gauge).
 Repeatability: ± 0.005 bar, ± 0.05 psi.
 Diaphragm Displacement: 0.01 ml typical.
 Filter: Sintered stainless steel, 50 micron pores.
 Materials: ABS and PVC plastic body, synthetic rubber diaphragm.
 Diameter: 25.4 mm (1").

PIEZOMETER ONLY

Pneumatic Piezometer 51417800
 Part number includes only piezometer. Tubing is attached to piezometer at factory and must be ordered at same time as piezometer.

PIEZOMETER WITH TUBING

Piezometer & 50' of tubing 51417801
 Piezometer & 100' of tubing 51417802
 Piezometer & 150' of tubing 51417803
 Piezometer & 200' of tubing 51417804
 Order numbers specify a pneumatic piezometer with tubing and quick-connect plug. These piezometers are stocked for faster delivery.

TUBING & CONNECTORS

Twin Tubing 51416900
 Two polyethylene tubes bundled in polyethylene jacket.
 Tubing Size: 4.76 mm with 1 mm wall (3/16" with 0.04" wall).
 Jacket: 12 mm x 7 mm with 1.1 mm wall (0.46" x 0.28" with 0.045" wall).
 Burst Pressure: 3.4 MPa (500 psi).
 Minimum Bending Radius: 75 mm (3").
 Tubing Buoyancy: 0.021 kg per m (0.014 lb per foot).
 Weight: 0.06 kg per meter (0.04 lb per foot).
 Splice Kit 51401723
 Includes 3 brass unions, self-vulcanizing mastic pad, and sealing tape.
 Quick Connect Plug 51407302
 Brass quick-connect fitting for input tube. Plug includes in-line filter and 90° elbow for insertion into panel.

INSTALLATION ACCESSORIES

Small Canvas Bag 06240000
 Large Canvas Bag 06240001
 Convenient way to create sand filter around piezometer. Small bag measures 64 x 457 mm (2.5 x 18"). Large bag measures 114 x 457 mm (4.5 x 18").
 Push-In Well Point 51400099
 Steel well point for piezometer, 30 x 610 mm (1.25 x 24"), 2 kg (4.4 lb). This part number includes labor to insert piezometer into well point, but does not include piezometer, tubing, or quick-connect plug.

TERMINALS

Terminal Pipe, 6 Positions 51409900
 Heavy gauge, zinc-plated, iridium treated steel pipe, 70 mm x 2 m (2.75" x 80"). Inside panel accommodates quick connect plugs from 6 piezometers. Includes panel, panel nuts, locking cap, keyed-alike padlock, and 90° PVC sweep for tubing entry.
 Terminal Pipe, 20 Positions 51417100
 Heavy gauge, zinc plated steel pipe, 127 mm x 178 mm x 1.8 m (5" x 7" x 6'). Inside panel accommodates quick connect plugs from 20 piezometers. Includes panel and panel nuts, locking cap, keyed-alike padlock, and 90° PVC sweep for tubing entry.
 Terminal Box, 10 Positions 51401510
 Fiberglass box with lockable lid, 292 x 235 x 140 mm (11.5 X 9.25 x 5.5"). Inside panel accommodates quick connect fittings from 10 piezometers. Box can be mounted to wall or post. Includes panel and panel nuts.



256 Pneumatic Indicator

256 Pneumatic Indicator

The 256 pneumatic indicator is used to activate and read pneumatic piezometers, total pressure cells, and settlement cells.

The indicator employs top quality components and is constructed to withstand many years of hard use.

Overview of Operation

Before leaving for the site, check that the indicator's tank is charged with gas. The built-in tank holds more than 180 liters of gas (6.25 SCF), which is sufficient for busy reading schedules.

On site, set the pressure regulator. Proper regulation results in lower gas consumption and prevents damage to the pressure gauge.

Connect transducer tubing to the indicator using the included jumper tubing.

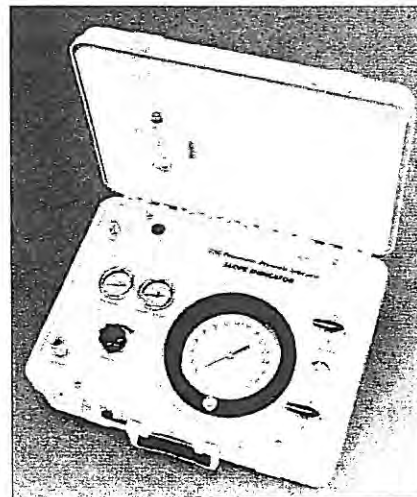
Turn on the gas to activate the transducer. Gas flows down through the tubing to the transducer.

Wait for the return-flow indicator to show a return flow of gas, then shut off the gas or use the precision flow-rate valve and flowmeter to slow the flow of gas.

Wait for the pressure reading on the main gauge to stabilize, then write down the reading. Take a second reading for verification, then disconnect and move to the next transducer.



256 Pneumatic Pressure Indicator with Digital Gauge



256 Indicator with Analog Gauge

Advantages

Choice of Pressure Gauges: Both digital and analog gauges are available. See the list of pressure gauges on the next page.

Precision Flowmeter: Use the precision flowmeter when reading with flow or when pressuring long lines.

High Quality Components: The 256 Indicator is built for hard and long use. It employs the best quality tube fittings, tubing, valves, gauges, and tank.

GAUGE SPECIFICATIONS

Accuracy	Range	Resolution
±0.25% Analog Gauge	30 psi	0.05 psi
	60 psi	0.1 psi
	100 psi	0.25 psi
	150 psi	0.5 psi
±0.05% Digital Gauge	200 psi	0.01 psi
	1400 kPa	0.01 kPa
	14 kg/cm ²	0.001 kg/cm ²
	13.8 bar	0.001 bar

Resolution of an analog gauge is one-half the smallest marked increment on the face plate of the gauge. Digital gauge provides a variety of preset metric and English units and can be programmed to display additional units.

INDICATOR SPECIFICATIONS

Pressure Gauge: 0.25% analog gauge or 0.05% digital gauge. Digital gauge uses a 9 volt battery.

Working Range: Determined by range of pressure gauge and by pressure regulator. Standard regulator outputs a maximum pressure of 1.24 MPa (180 psi).

Internal Tank: 1.38 liter (84 in³). Typical capacity is 180 liter (6.25 SCFH). Working pressure is 13.9 MPa (2015 psi). Recommended gas: dry nitrogen, 3 ppm H₂O maximum.

Precision Flowmeter: The flowmeter provides a repeatability of ±0.5% FS and is pressure rated for 1.7 MPa (250 psi). It is graduated in millimeters. When reading with flow, the recommended setting is a flowrate of 30 mm, which is equivalent to 0.1 SCFH or 47 cc/min.

Filler Hose: For filling tank from external nitrogen bottle. 2 m hose (7') with quick-connect fitting for indicator and screw-on fitting for external bottle.

Jumper Tubing: Connects indicator to terminal panel or to transducer tubing. 2 m jumper (7') with quick-connect fittings at each end. Twin-tube or triple-tube jumper is supplied, depending which options are ordered.

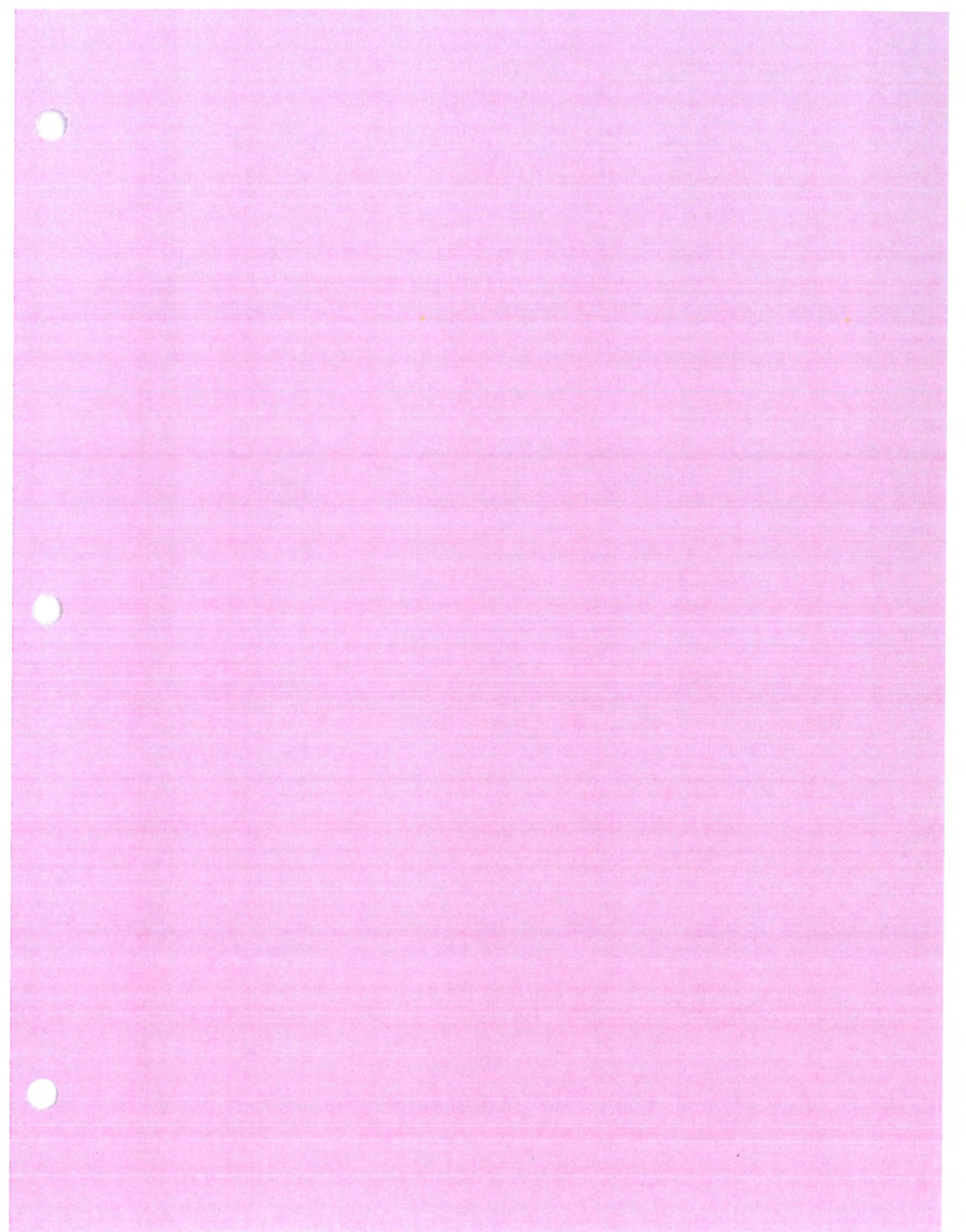
Weight: About 11 kg (24 lb) including full tank and jumper hose. Exact weight depends on selected options and pressure gauge.

Size: 508 x 457 x 178 mm (20 x 18 x 7").

256 INDICATOR

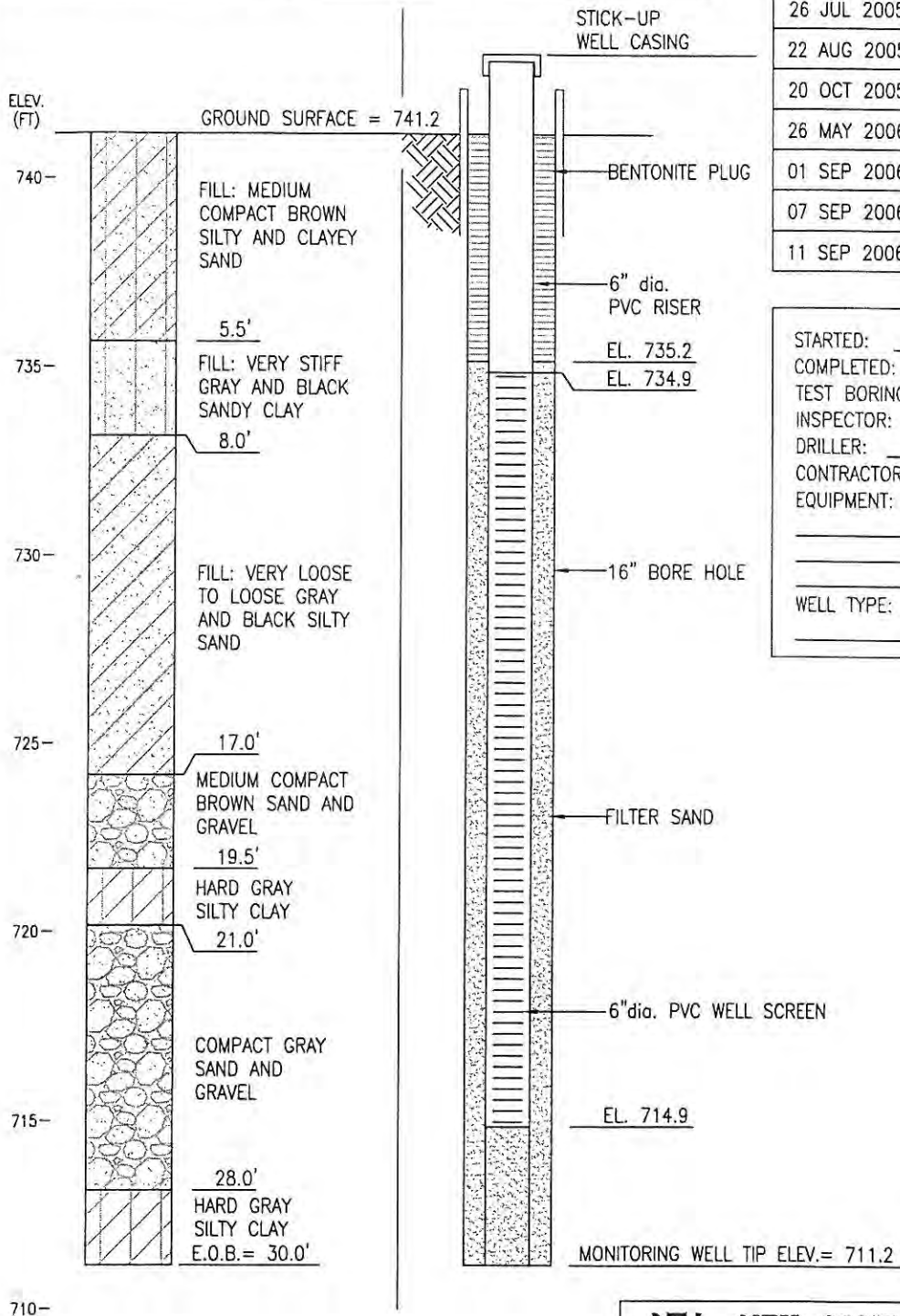
With 0.25% Analog Gauge 51425601
 With 0.05% Digital Gauge 51425602

Twin-tube indicator includes pressure gauge, precision flowmeter, filler hose, twin-tube jumper, and manual. Please specify range and units for pressure gauge. Indicators shipped by air have empty tank.




LOG TEST WELL No. PW-1	
CLASSIFIED BY: NTH CONSULTANTS, LTD.	
GENERALIZED SUBSURFACE PROFILE	SCHEMATIC

DATE	ELEVATION (FEET)
25 MAY 2005	736.4
10 JUN 2005	729.3
26 JUL 2005	729.7
22 AUG 2005	729.5
20 OCT 2005	729.5
26 MAY 2006	730.6
01 SEP 2006	729.7
07 SEP 2006	729.7
11 SEP 2006	729.6



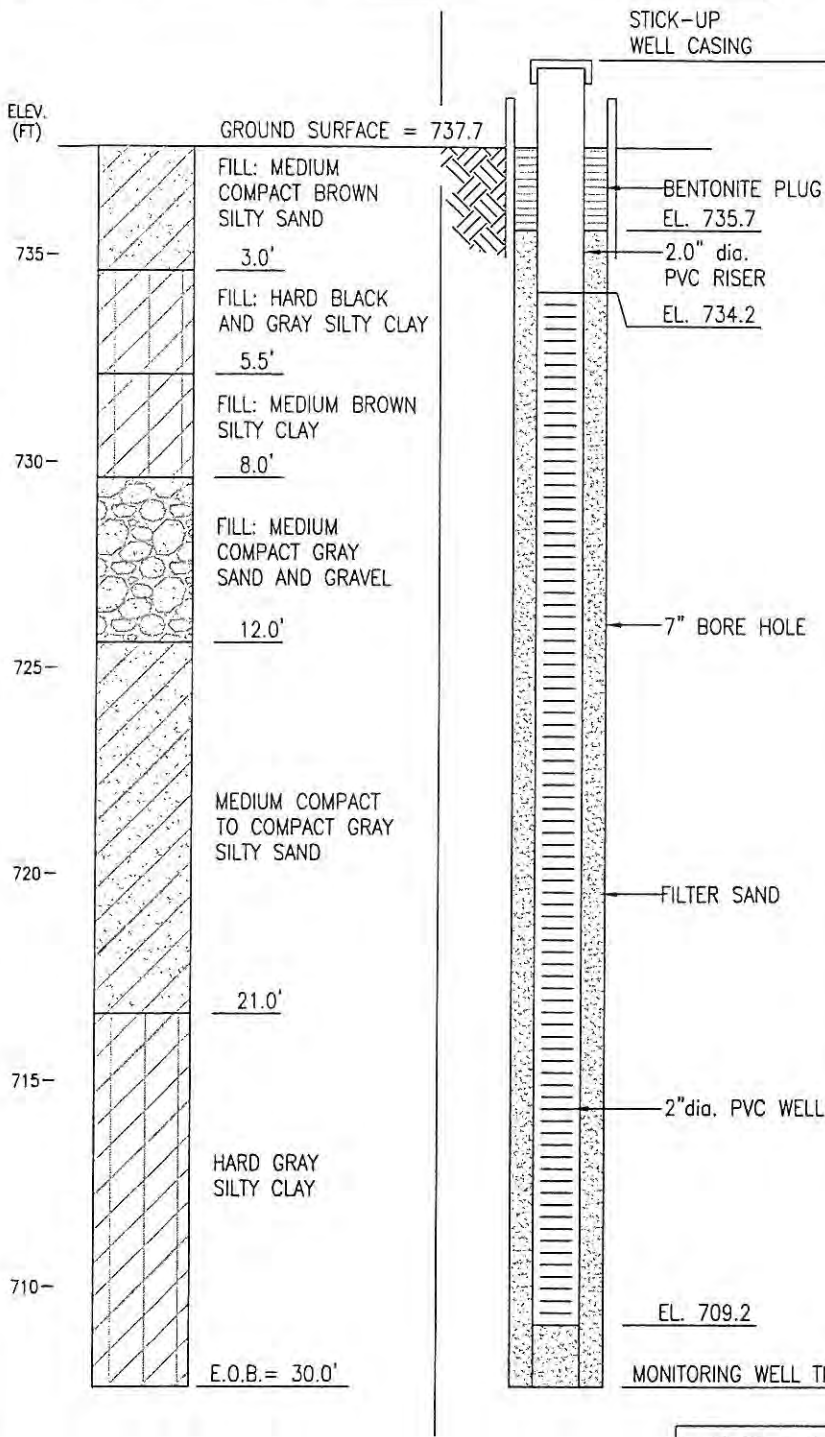
STARTED:	24 MAY 2005
COMPLETED:	25 MAY 2005
TEST BORING:	TB-110
INSPECTOR:	C. JOHNSON
DRILLER:	J. BLANK
CONTRACTOR:	AMERICAN DRILLING
EQUIPMENT:	CME 75 DRILL RIG
WELL TYPE:	PUMPING WELL

D050510PW1 12 SEP 2005

 NTH CONSULTANTS, LTD. Professional Engineering & Environmental Services Detroit, Michigan			
MONITORING WELL No. PW-1			
ANN ARBOR WASTEWATER TREATMENT PLANT IMPROVEMENTS ANN ARBOR, MICHIGAN			
PROJECT NO. 15-050510-00	DRAWN BY: SHB	DATE: 12 SEP 2006	FIGURE NO.
SCALE: NONE	CHECKED BY: CRJ	SHEET 1 OF 1	16

LOG MONITORING WELL No. MW-101
 CLASSIFIED BY:
 NTH CONSULTANTS, LTD.
 GENERALIZED SUBSURFACE PROFILE SCHEMATIC

DATE	ELEVATION (FEET)
16 MAY 2005	730.3
18 MAY 2005	730.9
25 MAY 2005	730.2
10 JUN 2005	729.6
26 JUL 2005	729.0
22 AUG 2005	728.5
20 OCT 2005	728.2
26 MAY 2006	733.2
06 SEP 2006	730.3
07 SEP 2006	730.3
11 SEP 2006	730.3



STARTED: 16 MAY 2005
 COMPLETED: 16 MAY 2005
 TEST BORING: TB-101
 INSPECTOR: C. JOHNSON
 DRILLER: J. BLANK
 CONTRACTOR: AMERICAN DRILLING
 EQUIPMENT: CME 75 DRILL RIG

WELL TYPE: MONITORING WELL

D050510MW101 12 SEP 2005

NTH CONSULTANTS, LTD.
 Professional Engineering & Environmental Services
 Detroit, Michigan

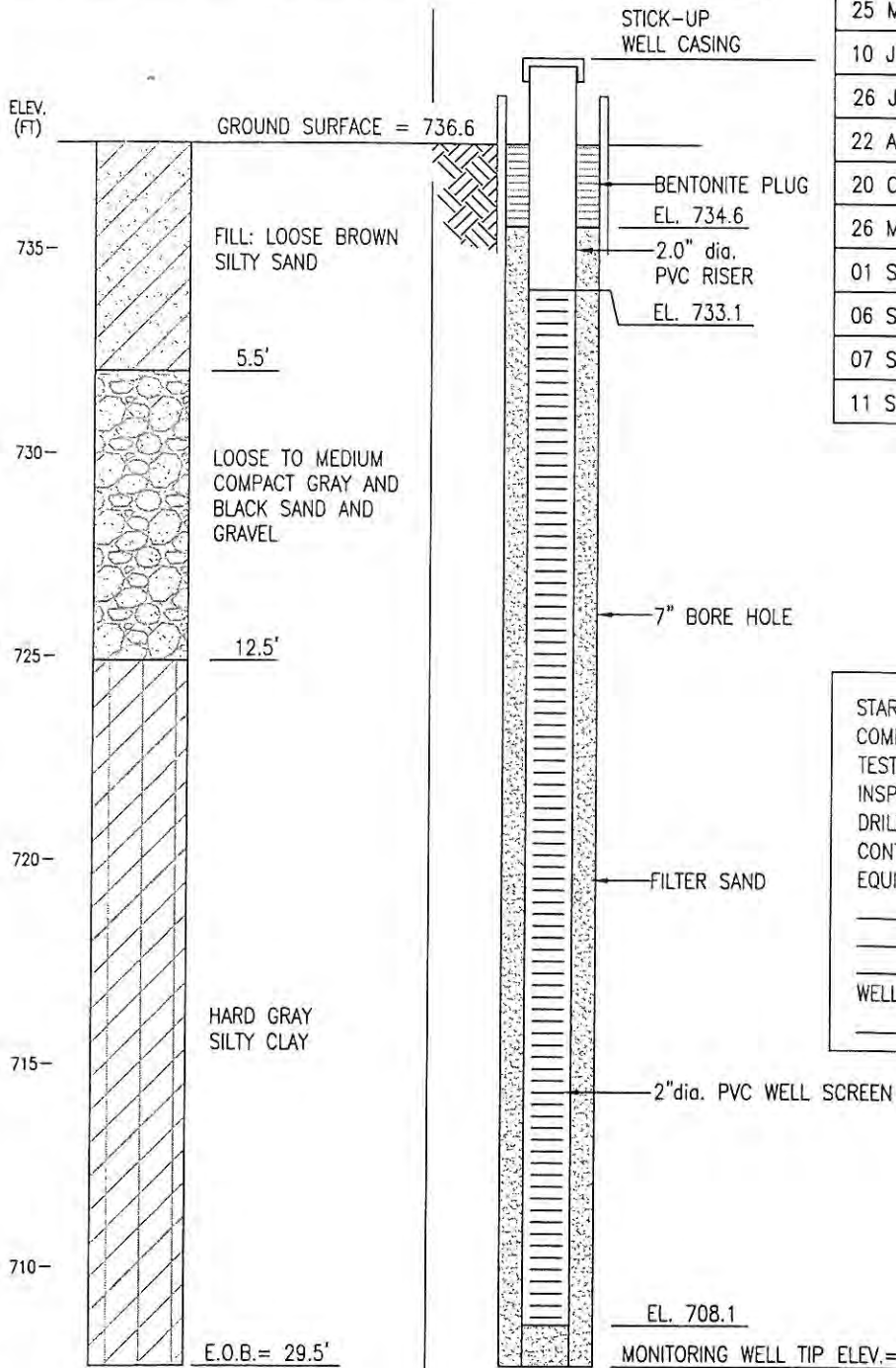
MONITORING WELL No. MW-101

ANN ARBOR WASTEWATER TREATMENT PLANT IMPROVEMENTS
 ANN ARBOR, MICHIGAN

PROJECT NO. 15-050510-00	DRAWN BY: SHB	DATE: 12 SEP 2006	FIGURE NO. 17
SCALE: NONE	CHECKED BY: CRJ	SHEET 1 OF 1	


LOG MONITORING WELL No. MW-103	
CLASSIFIED BY: NTH CONSULTANTS, LTD.	
GENERALIZED SUBSURFACE PROFILE	SCHEMATIC

DATE	ELEVATION (FEET)
16 MAY 2005	729.6
18 MAY 2005	729.7
25 MAY 2005	729.5
10 JUN 2005	728.3
26 JUL 2005	729.6
22 AUG 2005	727.8
20 OCT 2005	729.3
26 MAY 2006	730.4
01 SEP 2006	729.6
06 SEP 2006	727.9
07 SEP 2006	729.6
11 SEP 2006	729.5



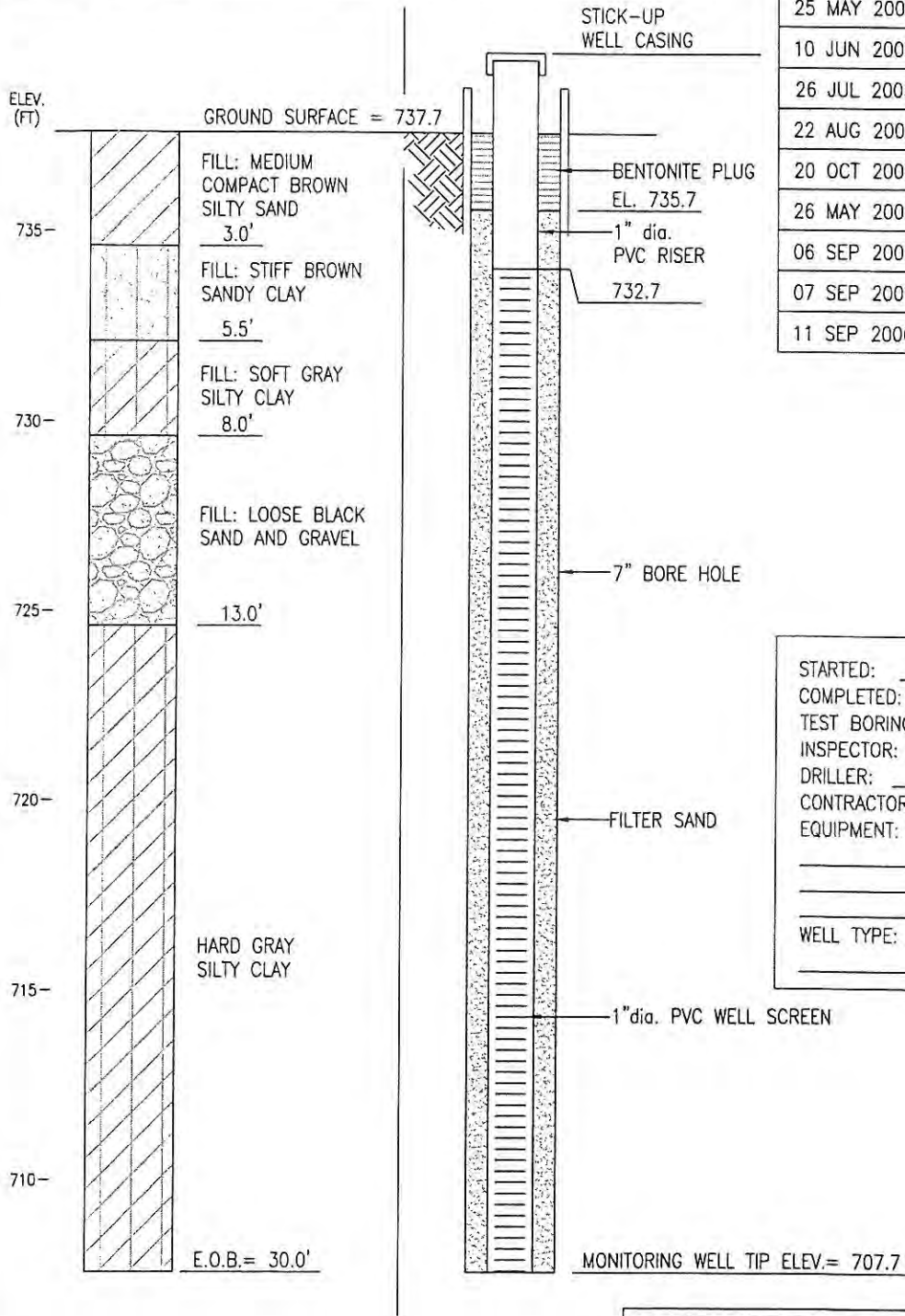
STARTED:	16 MAY 2005
COMPLETED:	16 MAY 2005
TEST BORING:	TB-103
INSPECTOR:	C. JOHNSON
DRILLER:	J. BLANK
CONTRACTOR:	AMERICAN DRILLING
EQUIPMENT:	CME 75 DRILL RIG
WELL TYPE: MONITORING WELL	

D050510MW103 12 SEP 2005

 NTH CONSULTANTS, LTD. Professional Engineering & Environmental Services Detroit, Michigan			
MONITORING WELL No. MW-103			
ANN ARBOR WASTEWATER TREATMENT PLANT IMPROVEMENTS ANN ARBOR, MICHIGAN			
PROJECT NO. 15-050510-00	DRAWN BY: SHB	DATE: 12 SEP 2006	FIGURE NO. 18
SCALE: NONE	CHECKED BY: CRJ	SHEET 1 OF 1	


LOG MONITORING WELL No. MW-104A	
CLASSIFIED BY: NTH CONSULTANTS, LTD.	
GENERALIZED SUBSURFACE PROFILE	SCHEMATIC

DATE	ELEVATION (FEET)
16 MAY 2005	728.5
18 MAY 2005	729.9
25 MAY 2005	729.6
10 JUN 2005	729.0
26 JUL 2005	729.4
22 AUG 2005	729.3
20 OCT 2005	729.0
26 MAY 2006	730.2
06 SEP 2006	729.4
07 SEP 2006	729.5
11 SEP 2006	729.3



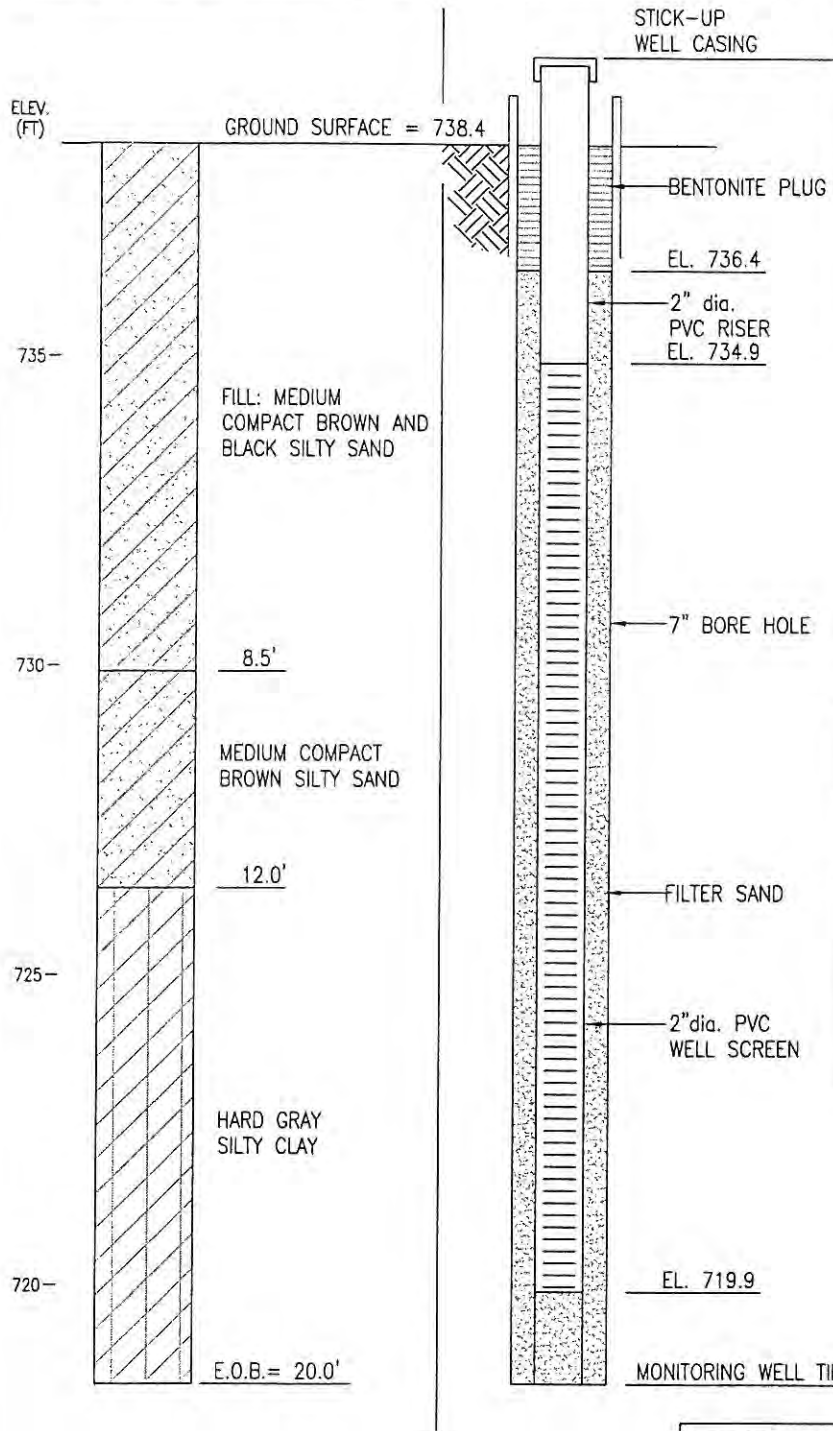
STARTED:	16 MAY 2005
COMPLETED:	16 MAY 2005
TEST BORING:	TB-104A
INSPECTOR:	C. JOHNSON
DRILLER:	J. BLANK
CONTRACTOR:	AMERICAN DRILLING
EQUIPMENT:	CME 75 DRILL RIG
WELL TYPE:	MONITORING WELL

D050510MM104A 12 SEP 2005

 NTH CONSULTANTS, LTD. Professional Engineering & Environmental Services Detroit, Michigan			
MONITORING WELL No. MW-104A			
ANN ARBOR WASTEWATER TREATMENT PLANT IMPROVEMENTS ANN ARBOR, MICHIGAN			
PROJECT NO. 15-050510-00	DRAWN BY: SHB	DATE: 12 SEP 2006	FIGURE NO.
SCALE: NONE	CHECKED BY: CRJ	SHEET 1 OF 1	19


LOG MONITORING WELL No. MW-105	
CLASSIFIED BY: NTH CONSULTANTS, LTD.	
GENERALIZED SUBSURFACE PROFILE	SCHEMATIC

DATE	ELEVATION (FEET)
18 MAY 2005	729.4
25 MAY 2005	730.0
10 JUN 2005	729.7
26 JUL 2005	729.6
22 AUG 2005	729.4
20 OCT 2005	729.3
26 MAY 2006	728.5
01 SEP 2006	729.6
06 SEP 2006	729.7
11 SEP 2006	729.8



STARTED:	18 MAY 2005
COMPLETED:	18 MAY 2005
TEST BORING:	TB-105
INSPECTOR:	C. JOHNSON
DRILLER:	J. BLANK
CONTRACTOR:	AMERICAN DRILLING
EQUIPMENT:	CME 75 DRILL RIG
WELL TYPE:	MONITORING WELL

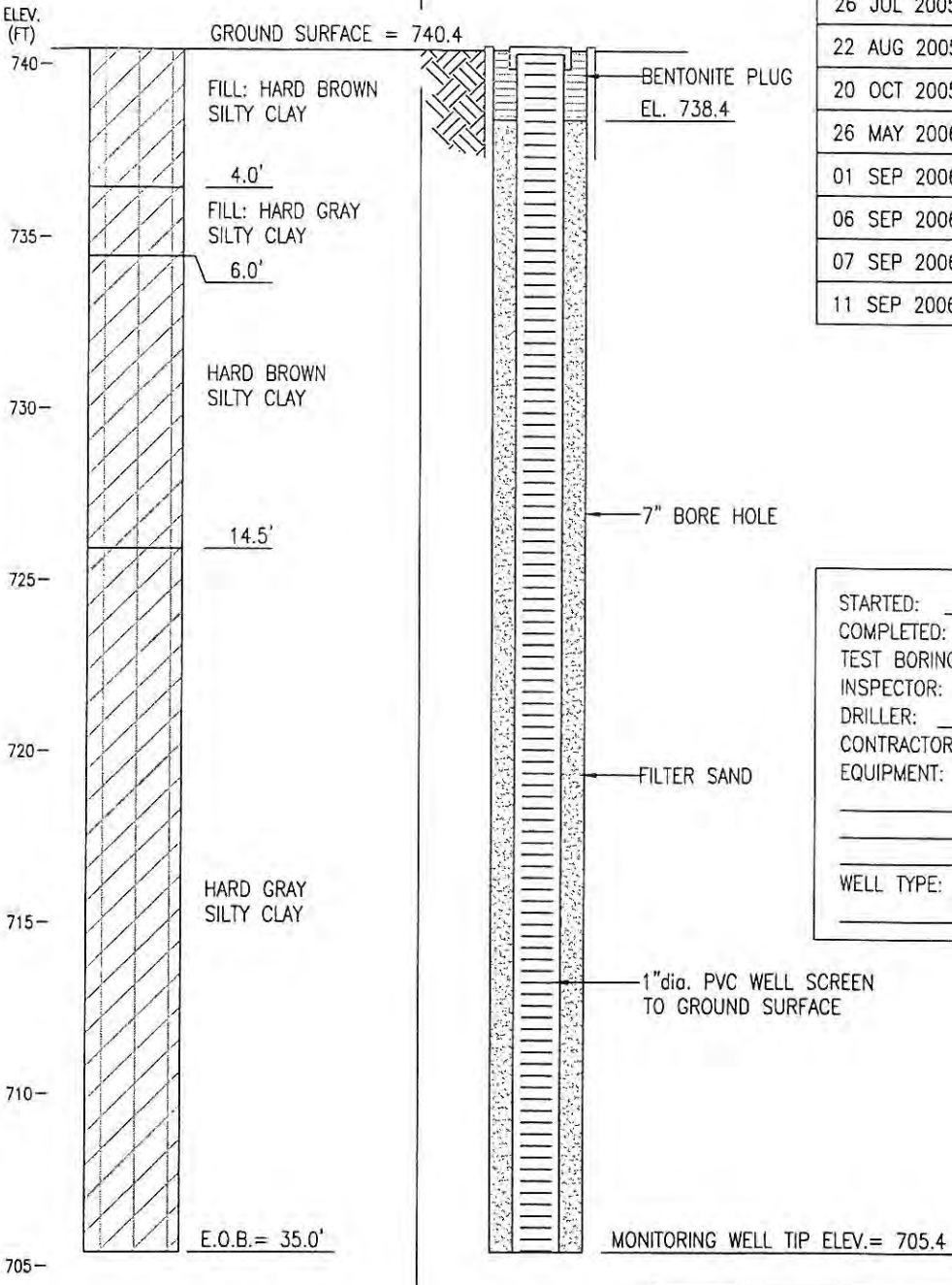
D050510MW105 12 SEP 2005

 NTH CONSULTANTS, LTD. Professional Engineering & Environmental Services Detroit, Michigan			
MONITORING WELL No. MW-105			
ANN ARBOR WASTEWATER TREATMENT PLANT IMPROVEMENTS ANN ARBOR, MICHIGAN			
PROJECT NO. 15-050510-00	DRAWN BY: SHB	DATE: 12 SEP 2006	FIGURE NO.
SCALE: NONE	CHECKED BY: CRJ	SHEET 1 OF 1	20

LOG MONITORING WELL No. MW-106
 CLASSIFIED BY:
 NTH CONSULTANTS, LTD.

GENERALIZED SUBSURFACE PROFILE	SCHEMATIC
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DATE	ELEVATION (FEET)
17 MAY 2005	NONE OBSERVED
18 MAY 2005	721.4
25 MAY 2005	733.5
10 JUN 2005	735.1
26 JUL 2005	734.6
22 AUG 2005	734.3
20 OCT 2005	733.9
26 MAY 2006	734.5
01 SEP 2006	734.5
06 SEP 2006	734.5
07 SEP 2006	734.5
11 SEP 2006	734.4



STARTED: 17 MAY 2005
 COMPLETED: 17 MAY 2005
 TEST BORING: TB-106
 INSPECTOR: C. JOHNSON
 DRILLER: J. BLANK
 CONTRACTOR: AMERICAN DRILLING
 EQUIPMENT: CME 75 DRILL RIG

WELL TYPE: MONITORING WELL

D050510MW106 12 SEP 2005

 NTH CONSULTANTS, LTD. Professional Engineering & Environmental Services Detroit, Michigan			
MONITORING WELL No. MW-106			
ANN ARBOR WASTEWATER TREATMENT PLANT IMPROVEMENTS ANN ARBOR, MICHIGAN			
PROJECT NO. 15-050510-00	DRAWN BY: SHB	DATE: 12 SEP 2006	FIGURE NO. 21
SCALE: NONE	CHECKED BY: CRJ	SHEET 1 OF 1	

Ref: *The Groundwater Geology and Hydrology of Washtenaw County and the Upper Huron River Basin*, by George R. Kunkle, Ph.D. dissertation, University of Michigan, 1960.

RECORD OF WELLS IN WASHTENAW COUNTY

Well No.	Location	Owner or Address	Driller	YD	TD	DB	D	A	Y	WL	Remarks
<u>Ann Arbor Township, continued</u>											
32-5	NW-NW-SW	Barnard Subdiv.	Dunbar	1941	165	-	-	920	475	88	Log, dd@425gpm=25'
32-6	SE-SE-SW	Main at Scio Church	Sorrell	-	250	-	-	920	-	-	0-250 gravel
33-1	NW-SE-SW	City of A.A.	-	-	125	-	-	830	-	15	Log
33-2	NE-SW-SW	City of A.A.	-	1932	203	203	-	831	-	15	Log
35-1	NW-NE-SE	-	-	-	158	-	6	752	-	-	Log, screen 143-154', pump test
35-2	SW-NE-SE	Sharnet	-	-	180	179	-	762	-	-	Log
35-7	NW-NW	Huron River Dr.	Cribley	-	-	130	-	770	-	-	0-130 drift, shale
36-1	NW-SE-NE	A.A. Sewage Treatment Plant	-	-	114	-	-	739	-	-	Log
<u>Augusta Township; WaAG,</u>											
9-1	SW-SW-SW	-	Cribley	-	150+	150	-	683	-	-	Limestone aquifer
20-1	SE-SW-SE	-	Cribley	-	130+	130	-	678	-	-	Limestone aquifer
27-1	SE-SE	Harmon	-	1911	203	50	-	665	-	-	Log
<u>Bridgewater Township; WaBw,</u>											
18-1	SE-SE-NE	Hanson	Palmer	1954	1414	165	-	902	-	-	O&G #18930
19-1	SE-SW-SE	Kulenkamp	-	1954	1285	183	-	868	-	-	O&G #18875, 0-183 drift, -880 Coldwater shale
20-1	SW-NW-SW	Glenbrook	-	1947	74	-	8	-	-	35	Log
21-1	NW-NW-NE	Collins	-	1954	1045	156	-	850	-	-	O&G #18886, 0-156 drift, -390 Coldwater shale, blue
26-1	NE-NE-NW	Knight	Miller	1954	1037	170	-	859	-	-	O&G #18866, 0-170 drift, -300 Coldwater shale, blue
27-1	NE-SW-SW	Allen	-	1954	1100	212	-	901	-	-	O&G #18870, 0-212 drift, -337 Coldwater shale, blue & gray

FIGURE 22

Well logs in Washtenaw County

	thickness ft.	depth ft.		thickness ft.	depth ft.
WaAa, 33-1. Alt. 830.			WaAa, 35-1, continued		
Gravel & clay	10	10	Dirty coarse sand	4	105
Sand	6	16	Very coarse sand & gravel	4	109
Blue clay	14	30	Dirty coarse sand	4	113
WB sand	8	38	Fine dirty sand	4	117
Clay, stone, sand & hardpan	87	125	Clean med. sand	6	123
			Coarse sand & gravel	16	139
			Sandy clay	4	143
			Coarse sand & gravel	10	153
			Blue clay	5	158
WaAa, 33-2. Alt. 831.			WaAa, 36-1. Alt. 739.		
Clay	10	10	Surface soil, gravel, boulders	5	5
Sand	6	16	Yellow clay, small stones	25	30
Blue clay	14	30	Hard blue clay	54	84
WB sand	8	38	Fine gray sand, WB	7	91
Clay	28	66	Sand & gravel up to $\frac{1}{2}$ inch diameter	14	105
Hardpan	6	72	Finer sand & gravel	9	114
Clay	43	115			
Hardpan	6	121			
Clay	34	155			
Fine WB sand	20	175			
Clay & sand	6	181			
Coarse WB gravel	7	188			
Coarse WB sand	10	198			
Gravel	2	200			
Hardpan, clay & shale	2	202			
WaAa, 35-2. Alt. 762.			Augusta Township		
Stoney gravel	30	30	WaAg, 27-1. Alt. 665.		
Sandy clay	93	123	Sand	10	10
Gravel & dirty sand	4	127	Clay	37	47
Sandy clay	46	173	Hardpan	3	50
Sandstone, gray	7	180	Sand	$3\frac{1}{2}$	50 $\frac{1}{2}$
			Limestone	$3\frac{1}{2}$	54
			Sandstone	1	55
			Limestone	25	80
WaAa, 35-1. Alt. 752.			Bridgewater Township		
Sand, gravel & large rocks	8	8	WaBw, 18-1. Alt. 902.		
Blue clay	13	21	Drift	165	165
Very dirty fine sand	29	50	Coldwater shale	22	187
Sandy clay	3	53	Shale, gray	100	287
Dirty fine sand	27	80			
Sandy clay	21	101			

Ref: *The Groundwater Geology and Hydrology of Washtenaw County and the Upper Huron River Basin*, by George R. Kunkle, Ph.D. dissertation, University of Michigan, 1960.

WATER WELL RECORD
ACT 294 PA 1965

MICHIGAN DEPARTMENT
OF
PUBLIC HEALTH

1 LOCATION OF WELL										
County	Twp.	Fraction	Section No.	Town	Range					
Wash.	Ann Arbor	SE 1/4 SE 1/4 NW 1/4	30	2 1/2 S.	6 E 1/2					
Distance And Direction from Road Intersections			OWNER No. 		3 OWNER OF WELL: National Sanitation Foundation					
at Huron River					Address: 2355 Stadium Bldg, Ann Arbor, Mich.					
49 S. Dreibers Rd					4 WELL DEPTH: (completed) 96 ft. Date of Completion 4-17-69					
Street address & City of Well Location					5 <input checked="" type="checkbox"/> Cable tool <input type="checkbox"/> Rotary <input type="checkbox"/> Driven <input type="checkbox"/> Dug <input type="checkbox"/> Hollow rod <input type="checkbox"/> Jetted <input type="checkbox"/> Bored <input type="checkbox"/> _____					
2 FORMATION			THICKNESS OF STRATUM		DEPTH TO BOTTOM OF STRATUM		6 USE: <input type="checkbox"/> Domestic <input type="checkbox"/> Public Supply <input type="checkbox"/> Industry <input type="checkbox"/> Irrigation <input type="checkbox"/> Air Conditioning <input checked="" type="checkbox"/> Commercial <input type="checkbox"/> Test Well <input type="checkbox"/> _____			
Blue Clay			12		12		7 CASING: Threaded <input checked="" type="checkbox"/> Welded <input type="checkbox"/> Height: Above/Below surface _____ ft. Diam. 4 in. to 96 ft. Depth _____ lbs./ft. _____ in. to _____ ft. Depth _____ Drive Shoe? Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>			
Sand			2		15		8 SCREEN: Type: None Dia.: _____ Slot/Gauze _____ Length _____ Set between _____ ft. and _____ ft. Fittings: _____			
Blue Clay			29		94		9 STATIC WATER LEVEL 18' plus above ground ft. below land surface			
Gravel			2		96		10 PUMPING LEVEL below land surface Flow _____ ft. after 68 hrs. pumping 100 g.p.m. _____ ft. after _____ hrs. pumping _____ g.p.m.			
							11 WATER QUALITY in Parts Per Million: Iron (Fe) _____ Chlorides (Cl) _____ Hardness _____			
							12 WELL HEAD COMPLETION: <input type="checkbox"/> In Approved Pit <input checked="" type="checkbox"/> Pitless Adapter <input type="checkbox"/> 12" Above Grade			
							13 GROUTING: Well Grouted? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Material: <input type="checkbox"/> Neat Cement <input checked="" type="checkbox"/> Gel Depth: From _____ ft. to _____ ft.			
							14 SANITARY: Nearest Source of possible contamination _____ feet _____ Direction _____ Type _____ Well disinfected upon completion <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No			
							15 PUMP: Manufacturer's Name Deming Model Number 4786 HP 3/4 Length of Drop Pipe 0 ft. capacity 22 G.P.M. Type: <input type="checkbox"/> Submersible <input type="checkbox"/> _____ <input checked="" type="checkbox"/> Jet <input type="checkbox"/> Reciprocating			
16 Remarks, elevation, source of data, etc.					17 WATER WELL CONTRACTOR'S CERTIFICATION:					
Pressure line over section from Pitless to pump. Replacements					This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief. Cubley Drilling Co. 524 REGISTERED BUSINESS NAME REGISTRATION NO. Address: Dexter, Mich. Signed: J. G. Clark Date: 6-1-69 AUTHORIZED REPRESENTATIVE					

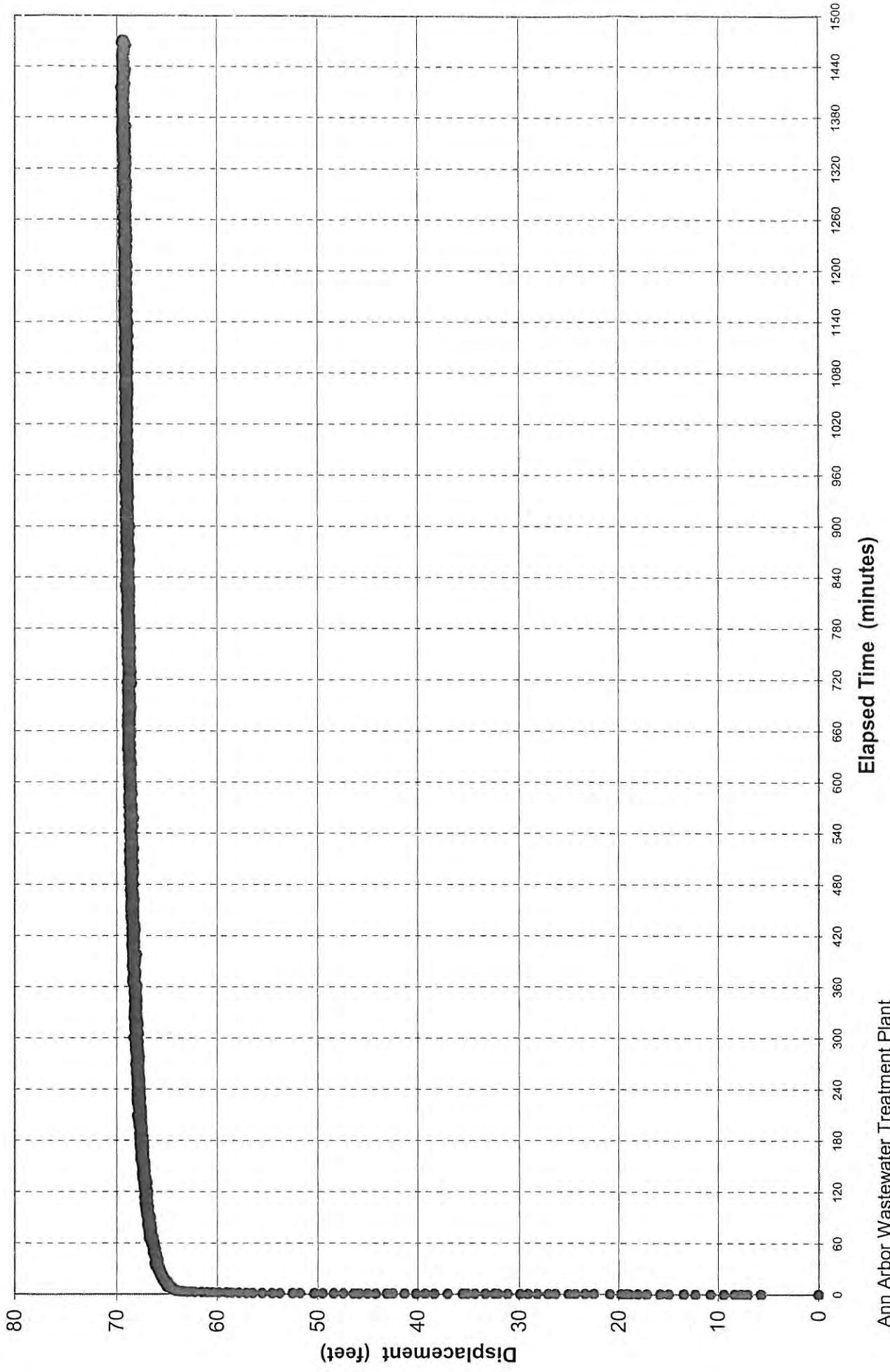


APPENDIX C

WATER LEVEL DATA PLOTS:

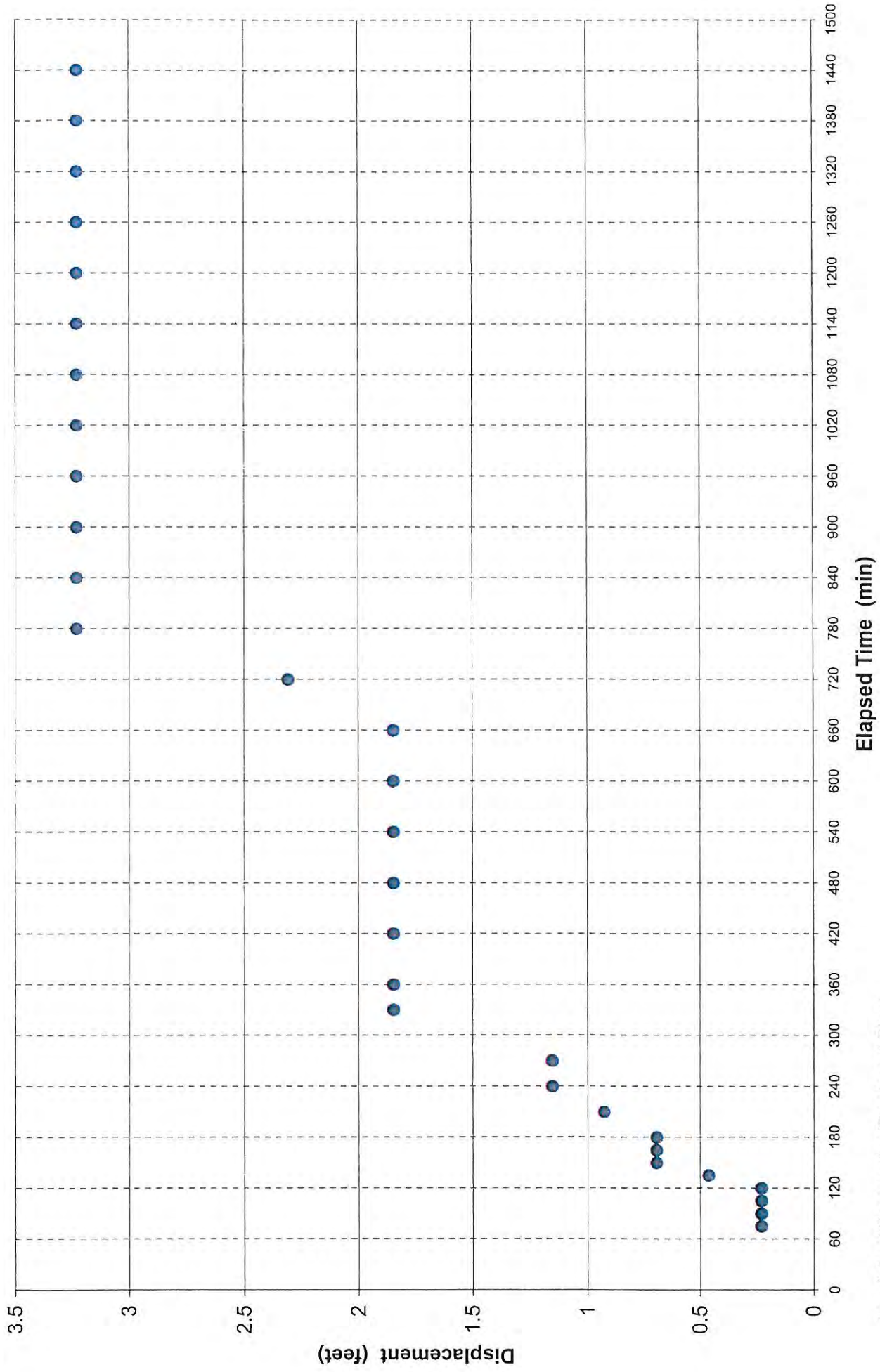
- **ARTESIAN AQUIFER**
 - **PUMPING TEST**
 - **RECOVERY PERIOD**
- **SHALLOW UNCONFINED AQUIFER**
 - **GROUNDWATER LEVEL GRAPHS (9/5/06 TO 9/12/06)**
- **HURON RIVER DATA PLOT**
- **BAROMETRIC PRESSURE PLOT**

PW-2 PUMP TEST

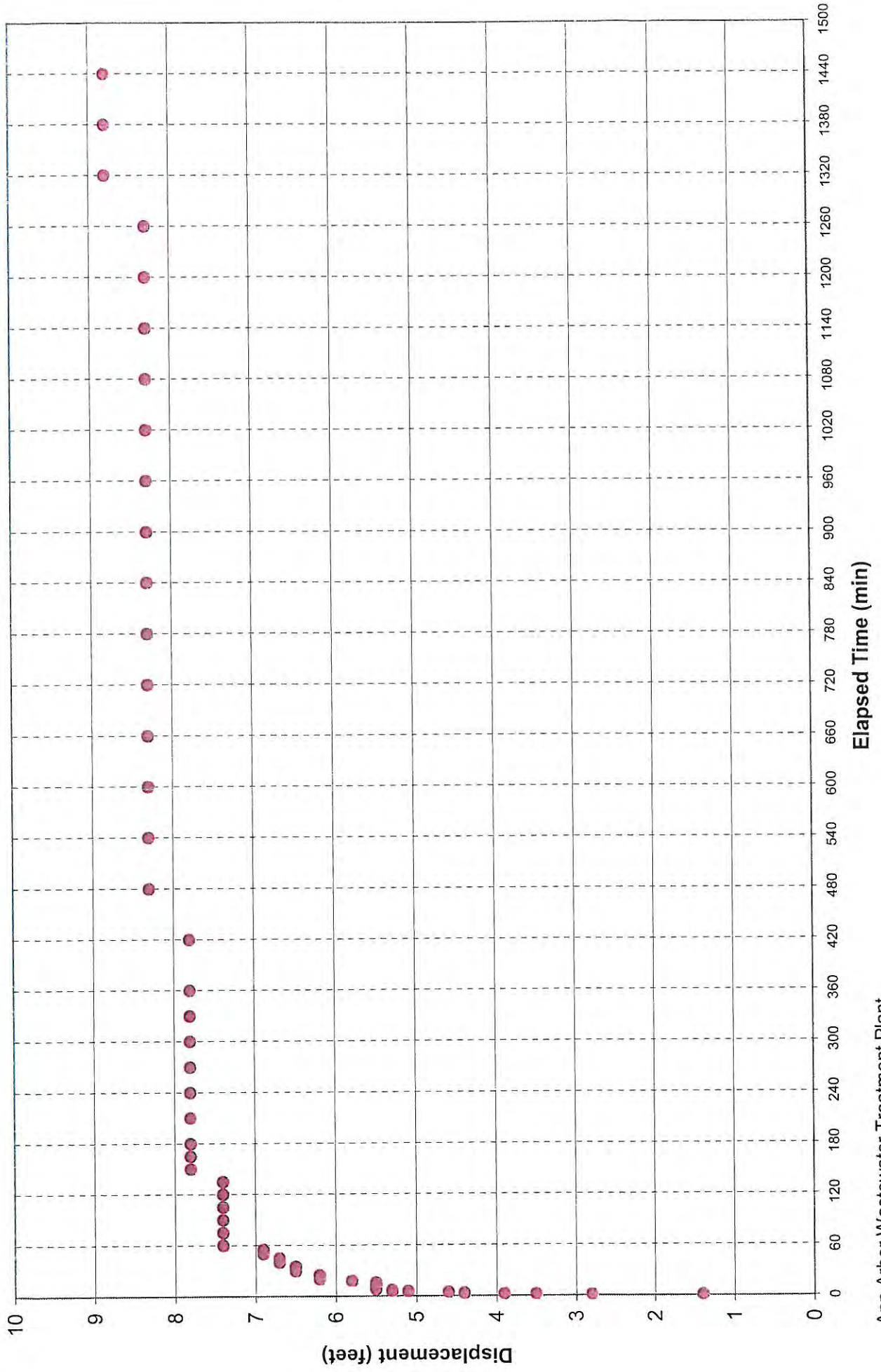


Ann Arbor Wastewater Treatment Plant
Aquifer Pumping Test Evaluation
October 10, 2006

PZ-107 PUMP TEST

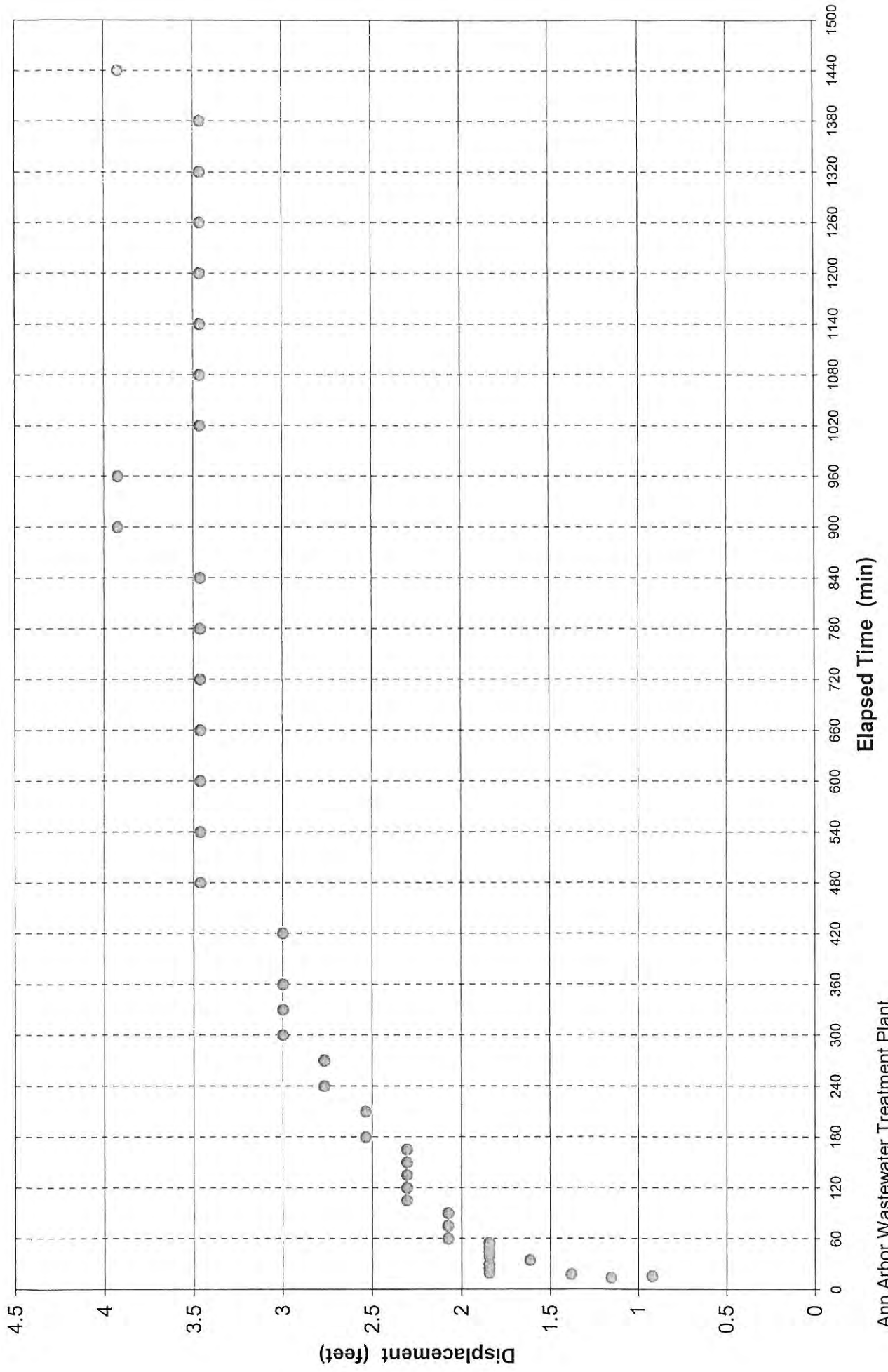


PZ-202 PUMP TEST

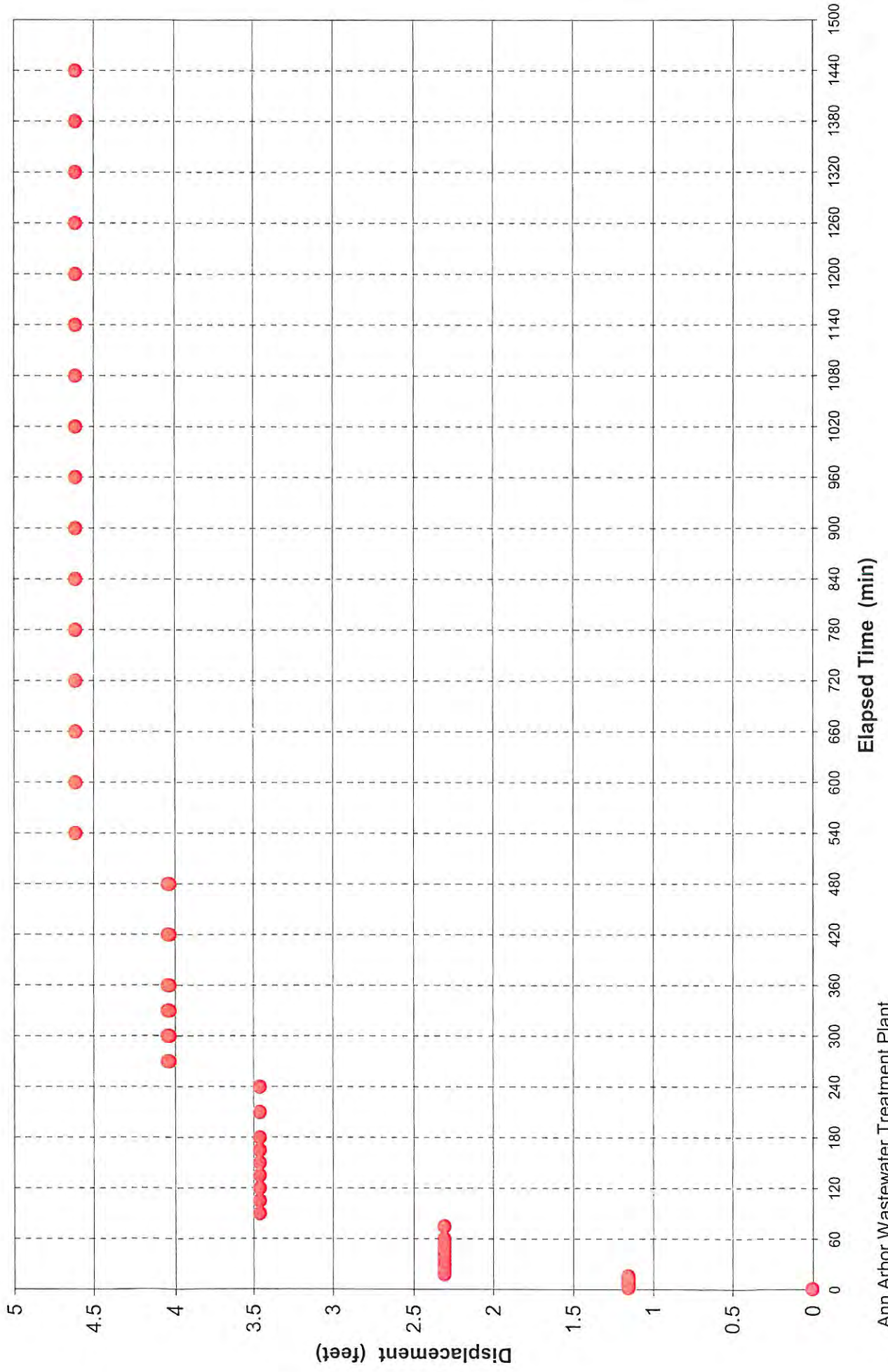


Ann Arbor Wastewater Treatment Plant
Aquifer Pumping Test Evaluation
October 10, 2006

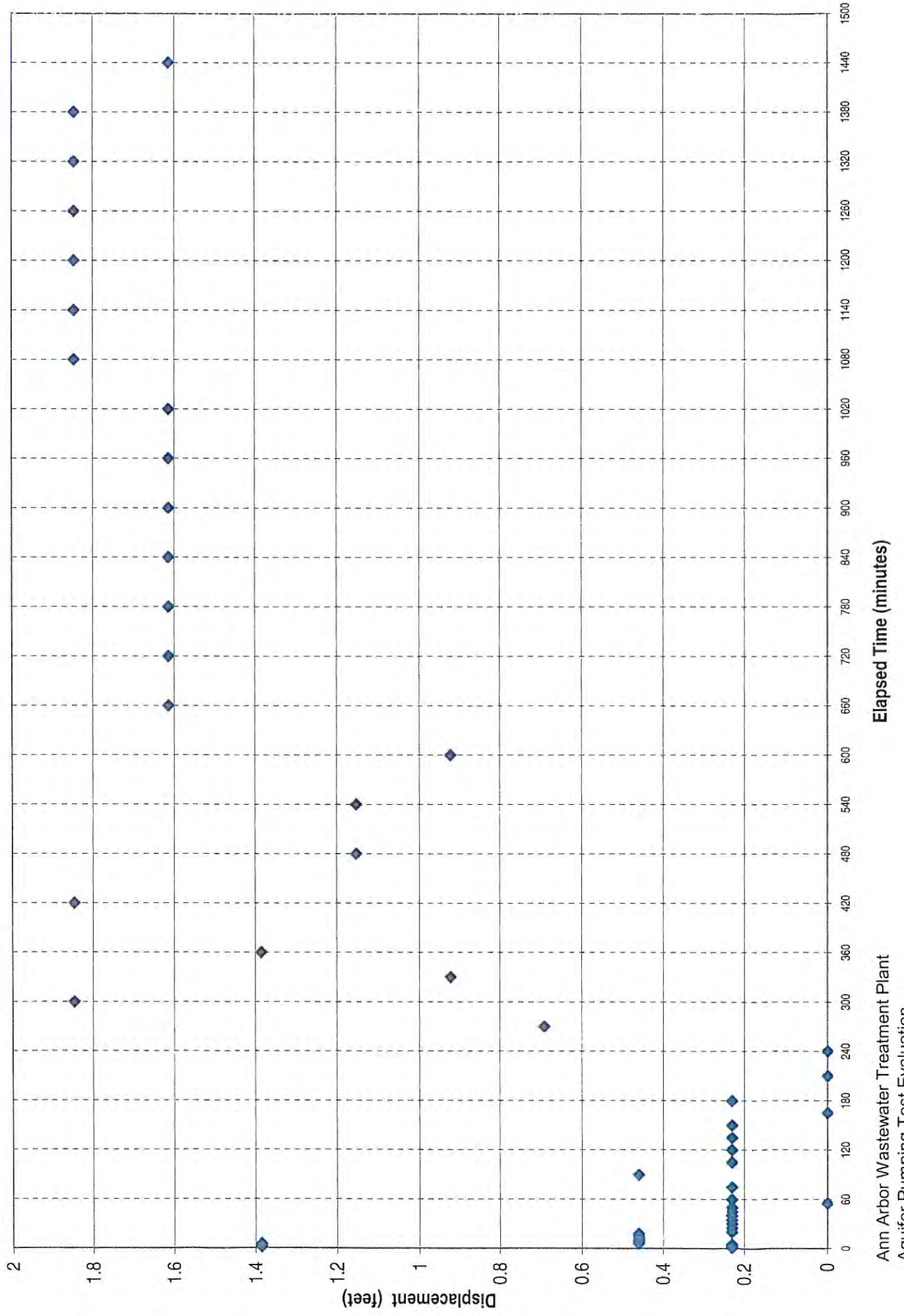
PZ-203 PUMP TEST



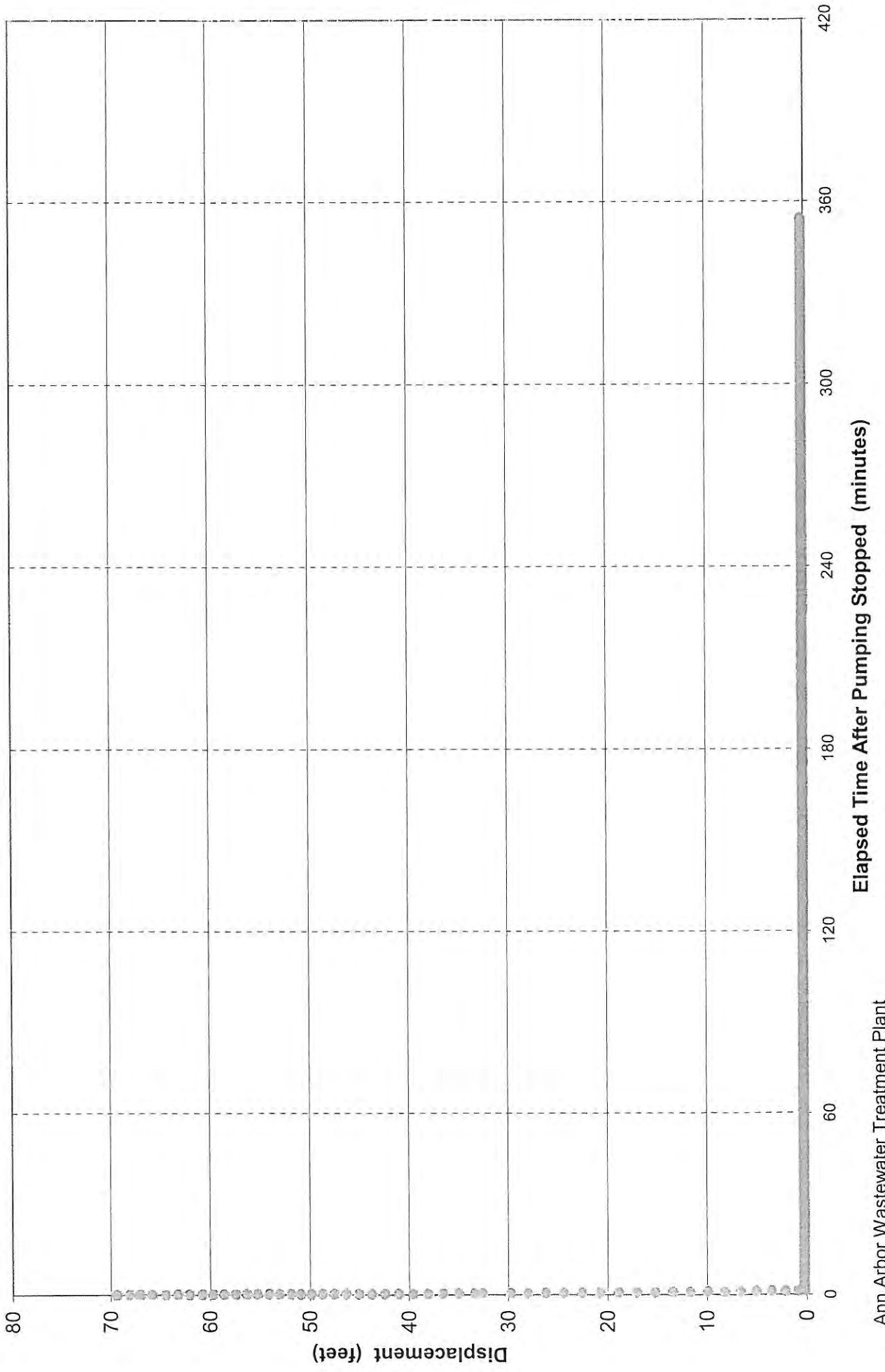
PZ-302 PUMP TEST



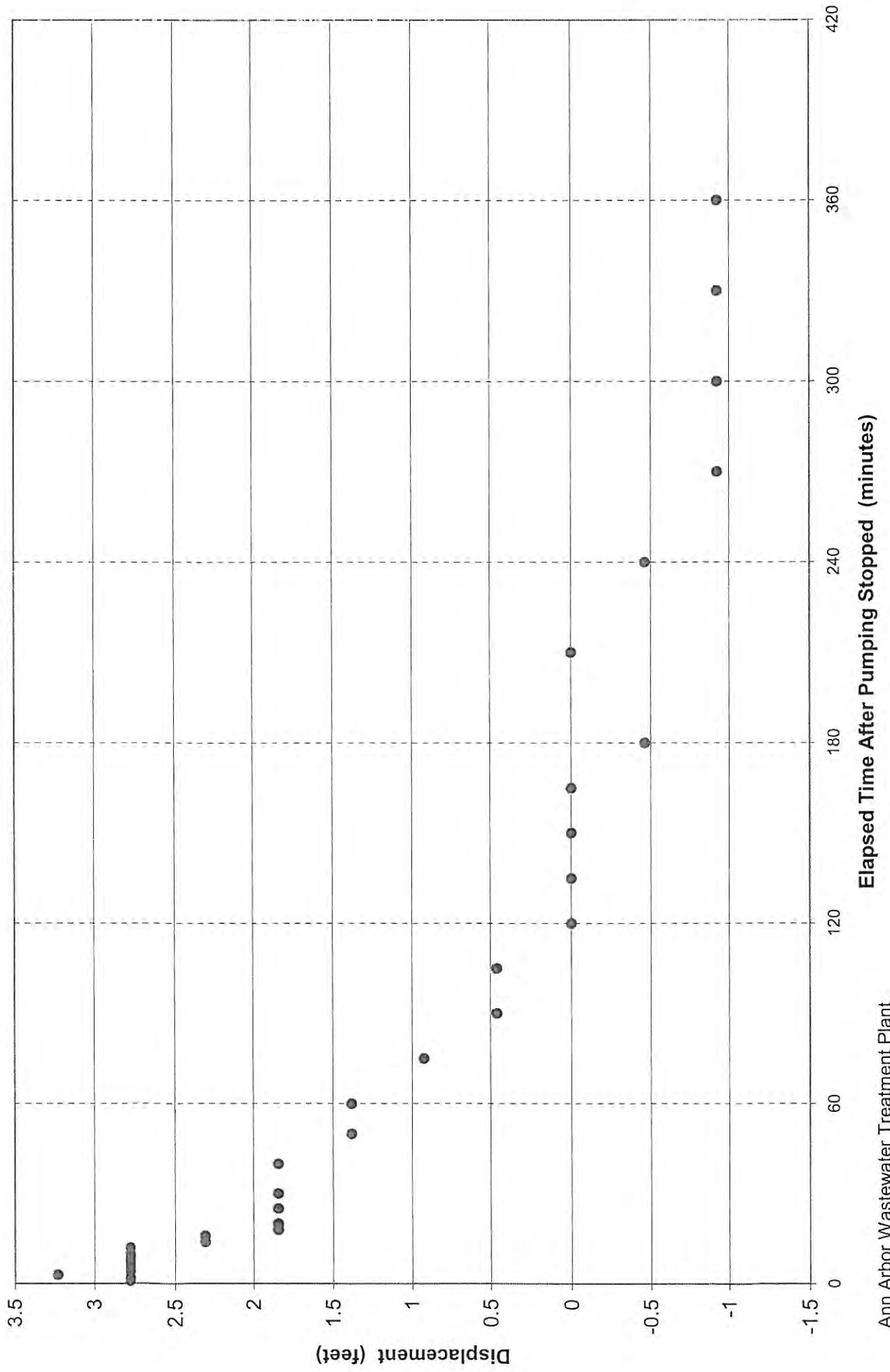
PZ-307 PUMP TEST



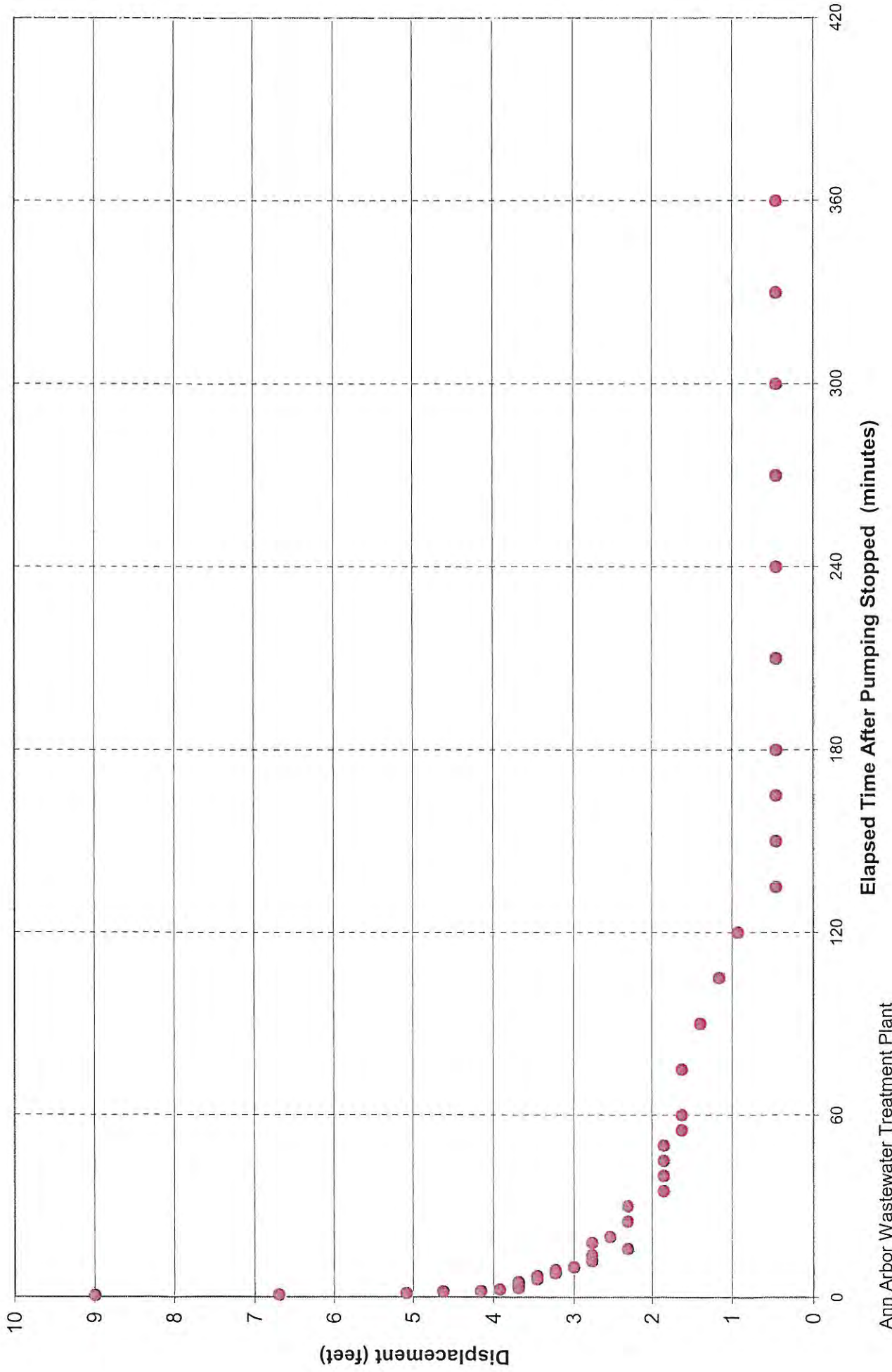
PW-2 RECOVERY



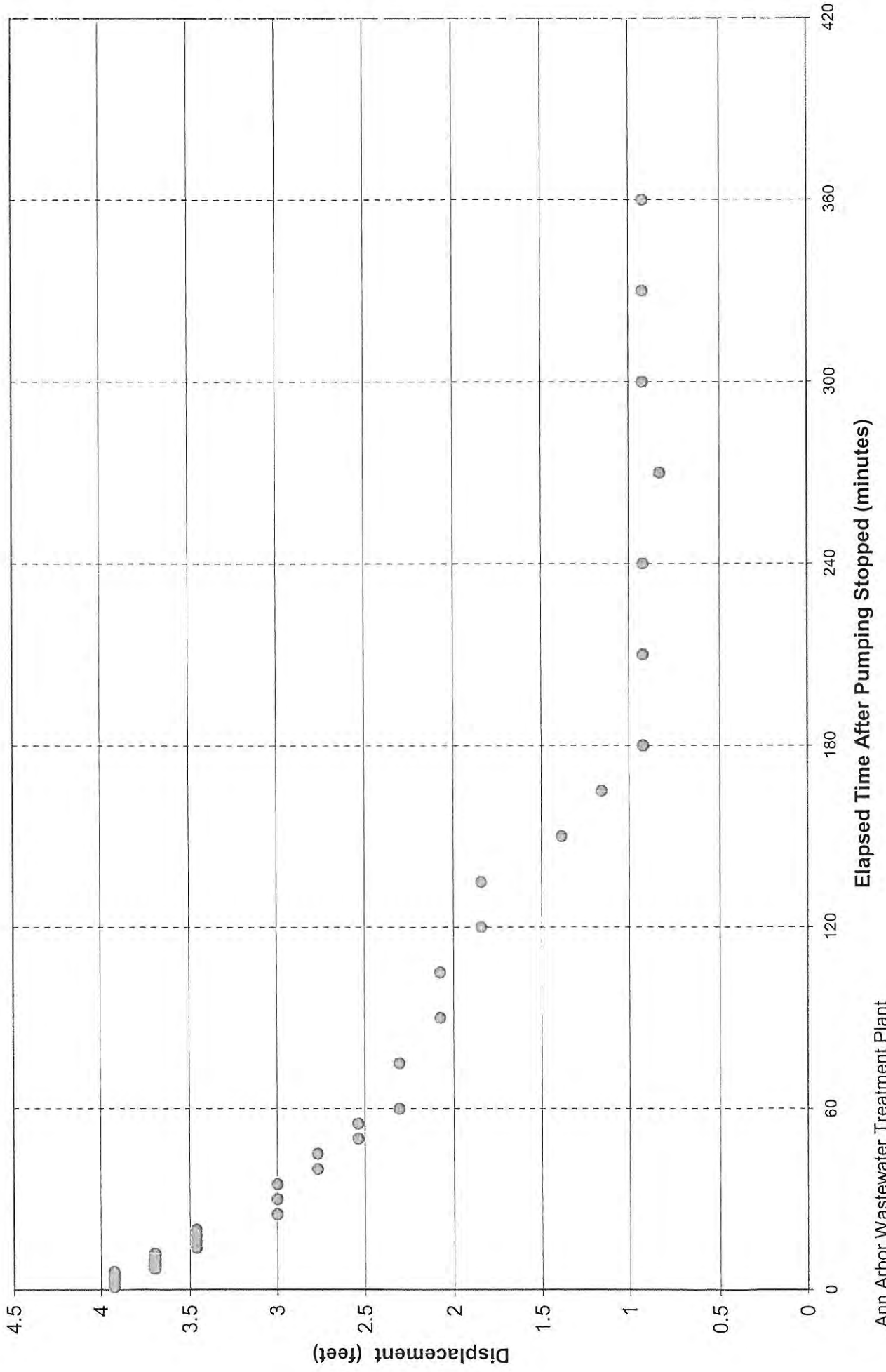
PZ-107 RECOVERY



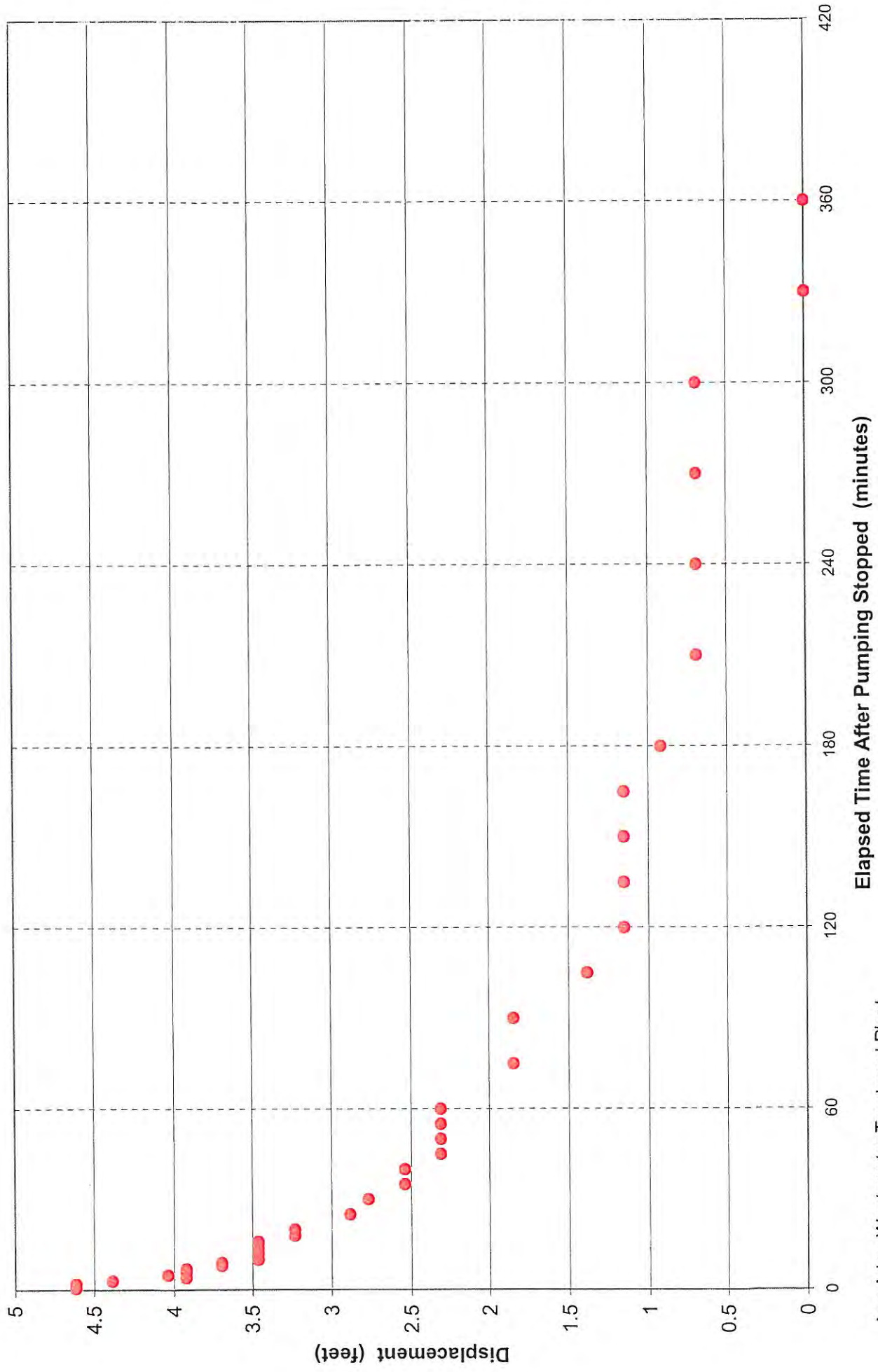
PZ-202 RECOVERY



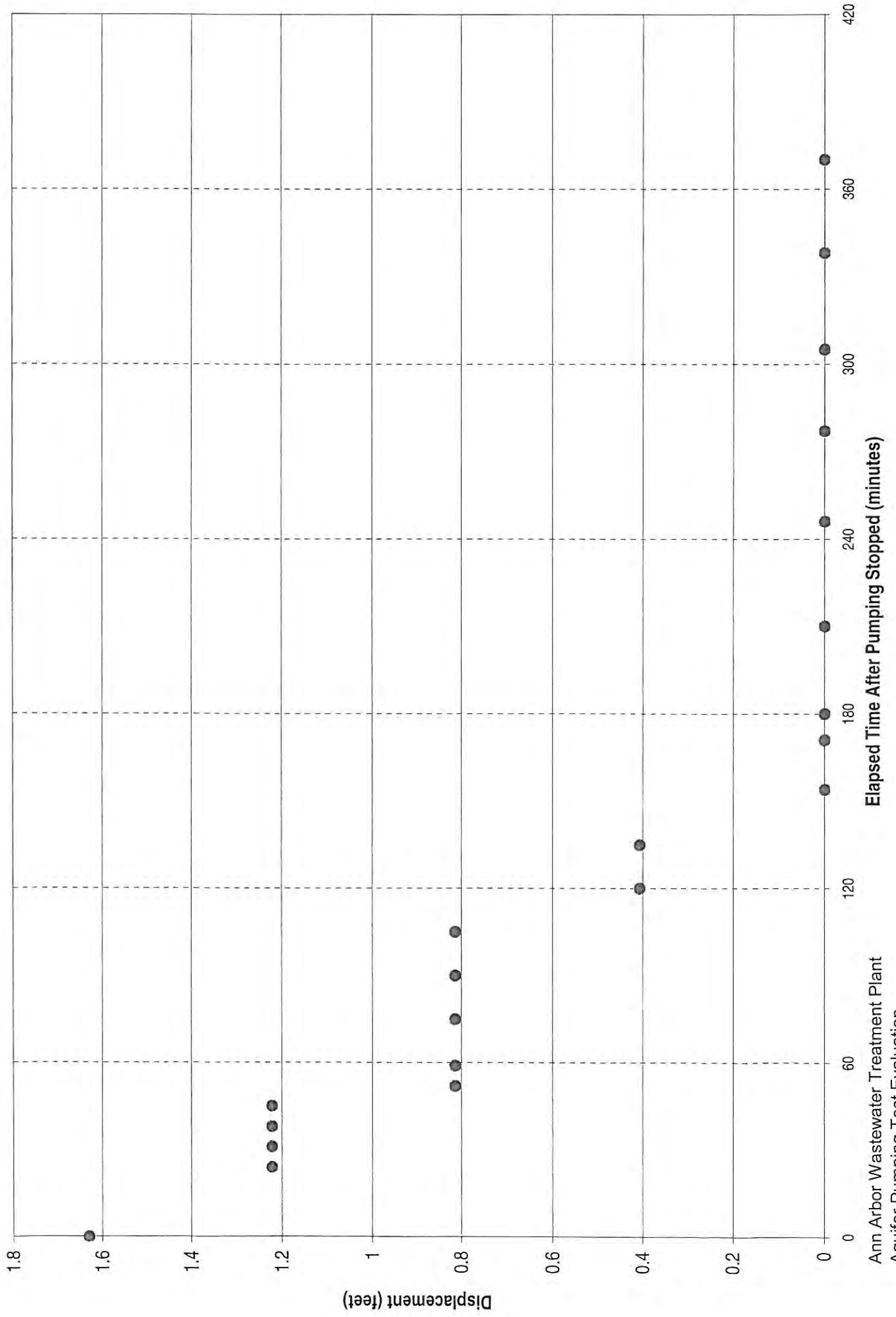
PZ-203 RECOVERY



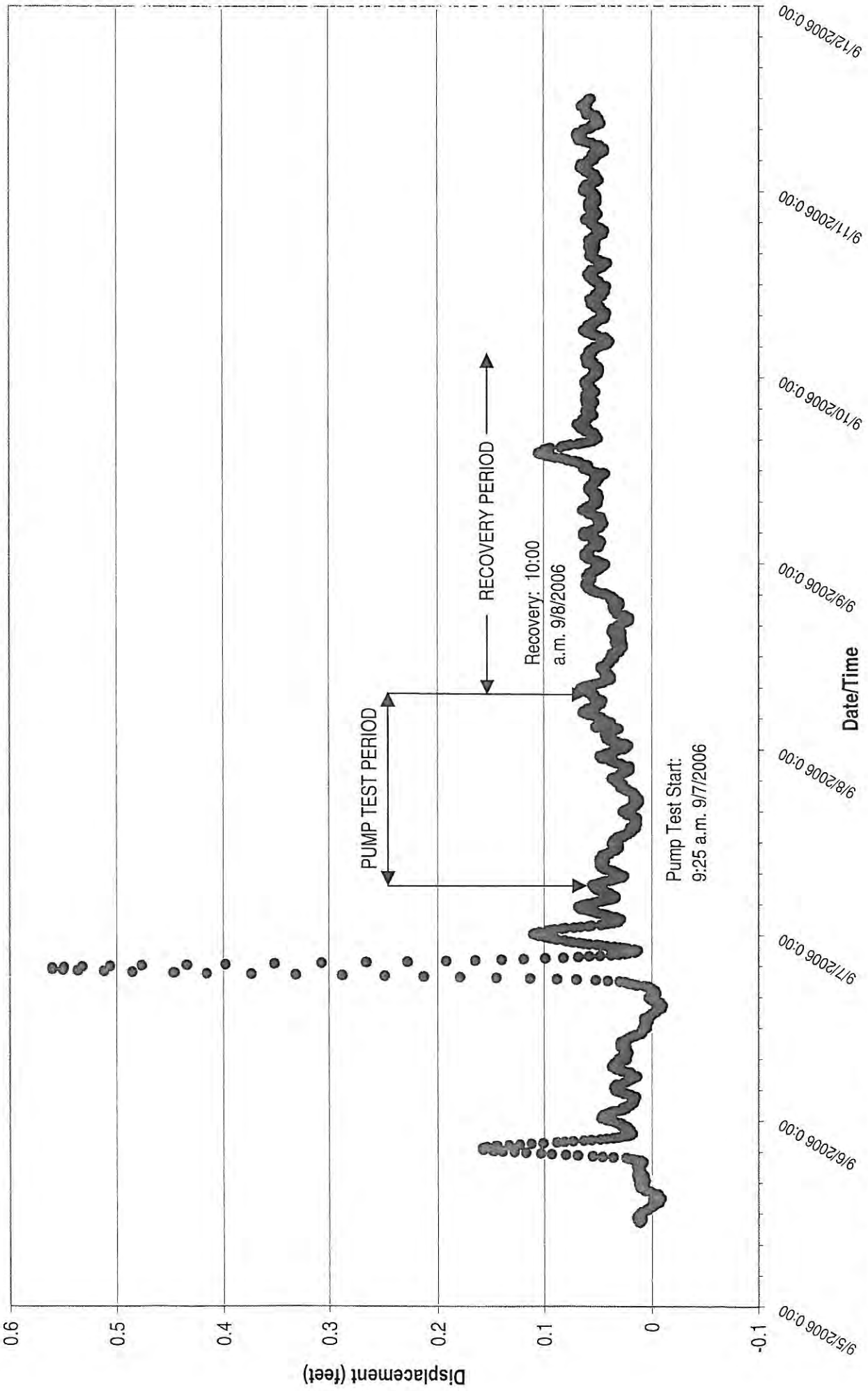
PZ-302 RECOVERY



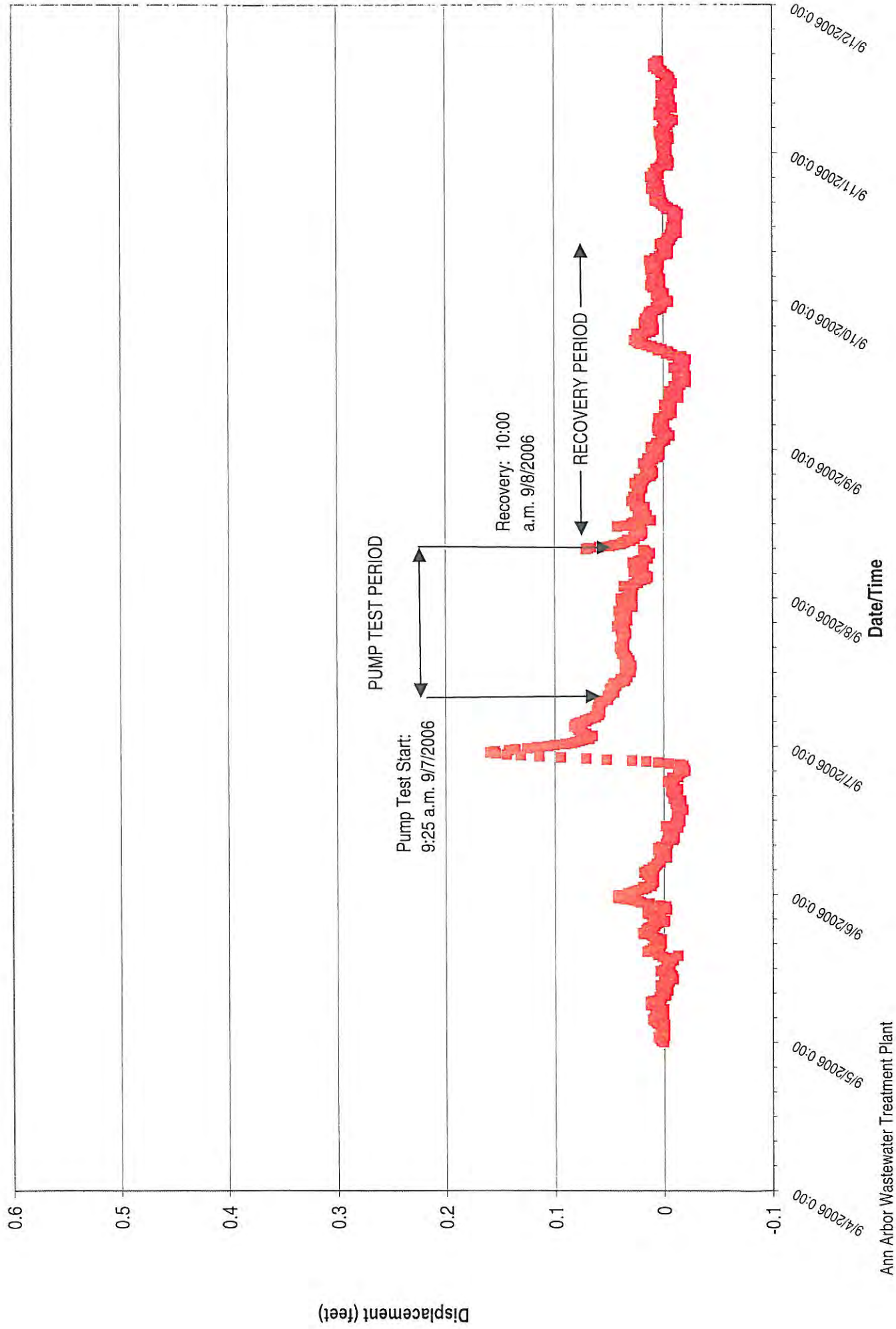
PZ-307 RECOVERY



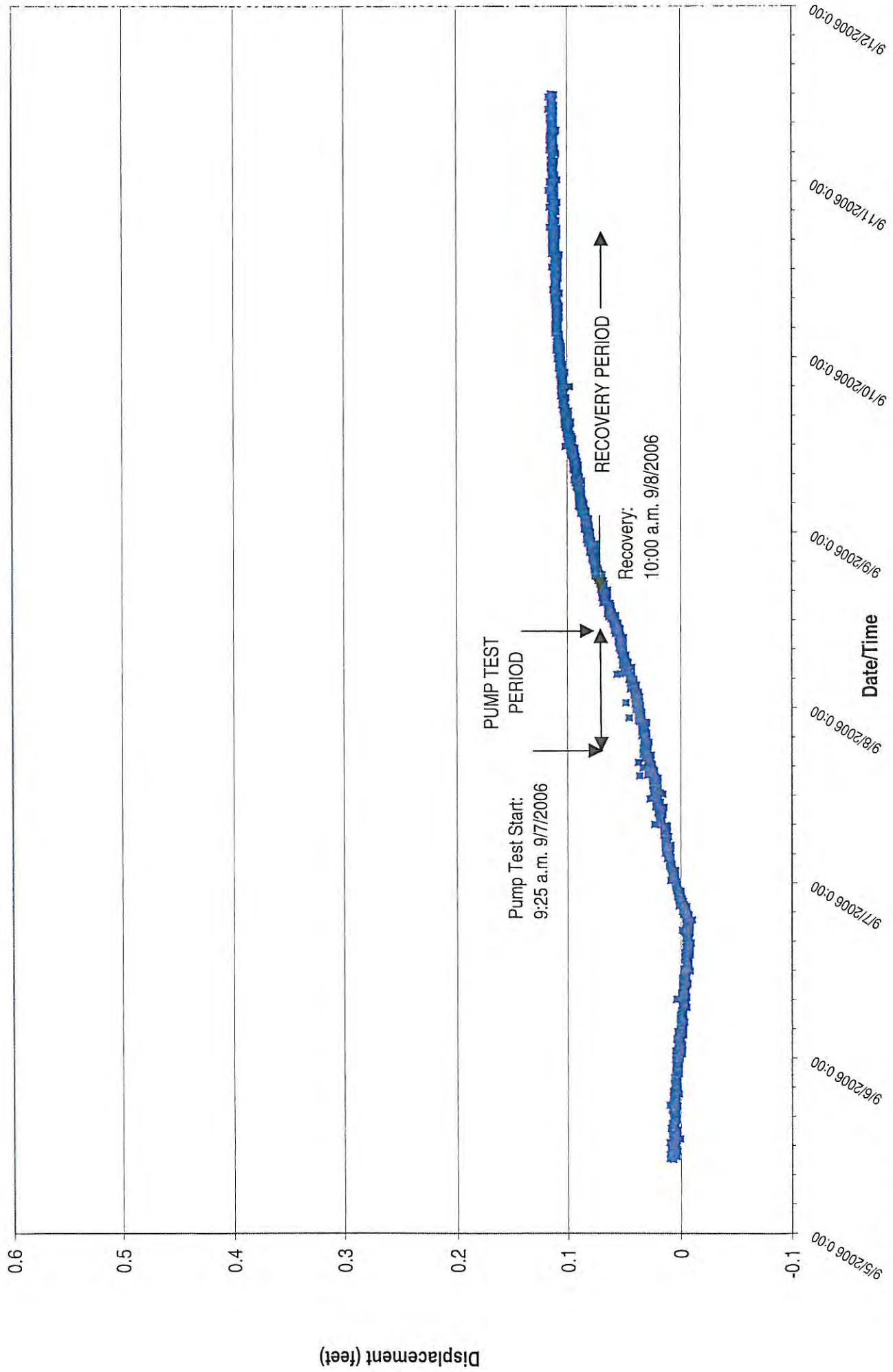
PW-1 Shallow Groundwater Level Data (9/5/06 thru 9/11/06)



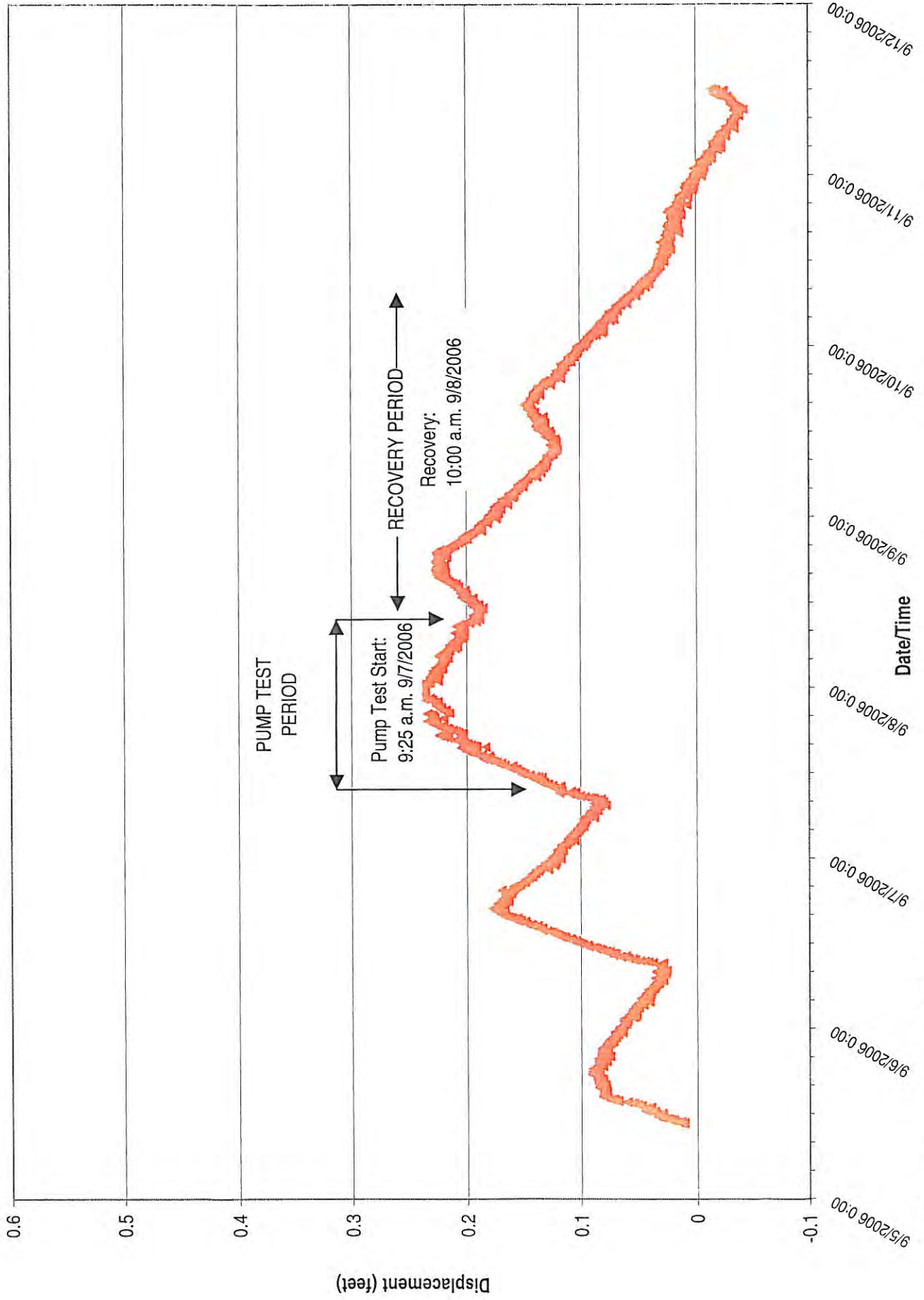
MW-103 Shallow Groundwater Level Data (9-5-06 thru 9-11-06)



MW-105 Shallow Groundwater Level Data (9-5-06 thru 9-11-06)

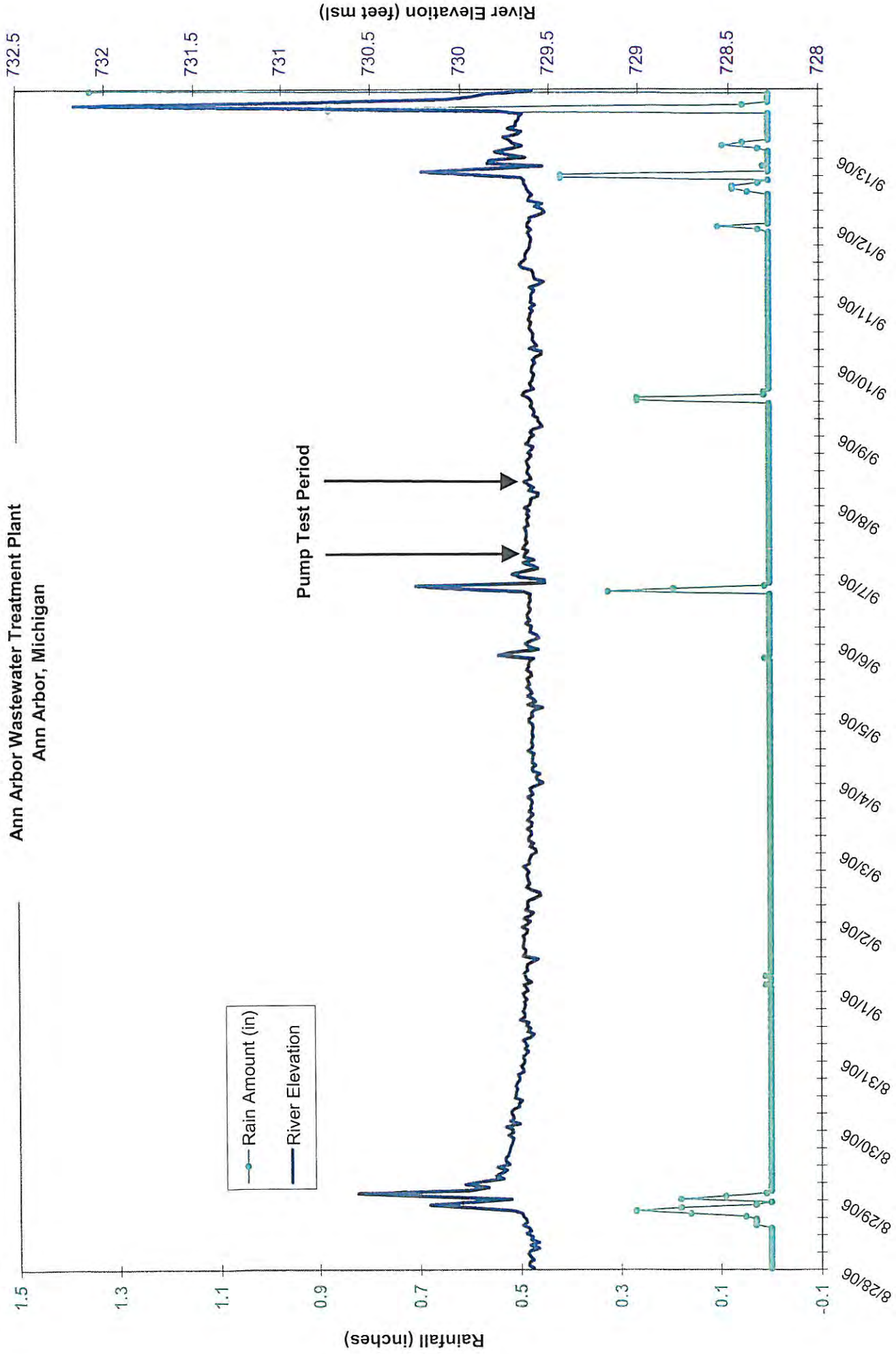


MW-106 Shallow Groundwater Level Data (9-5-06 thru 9-11-06)

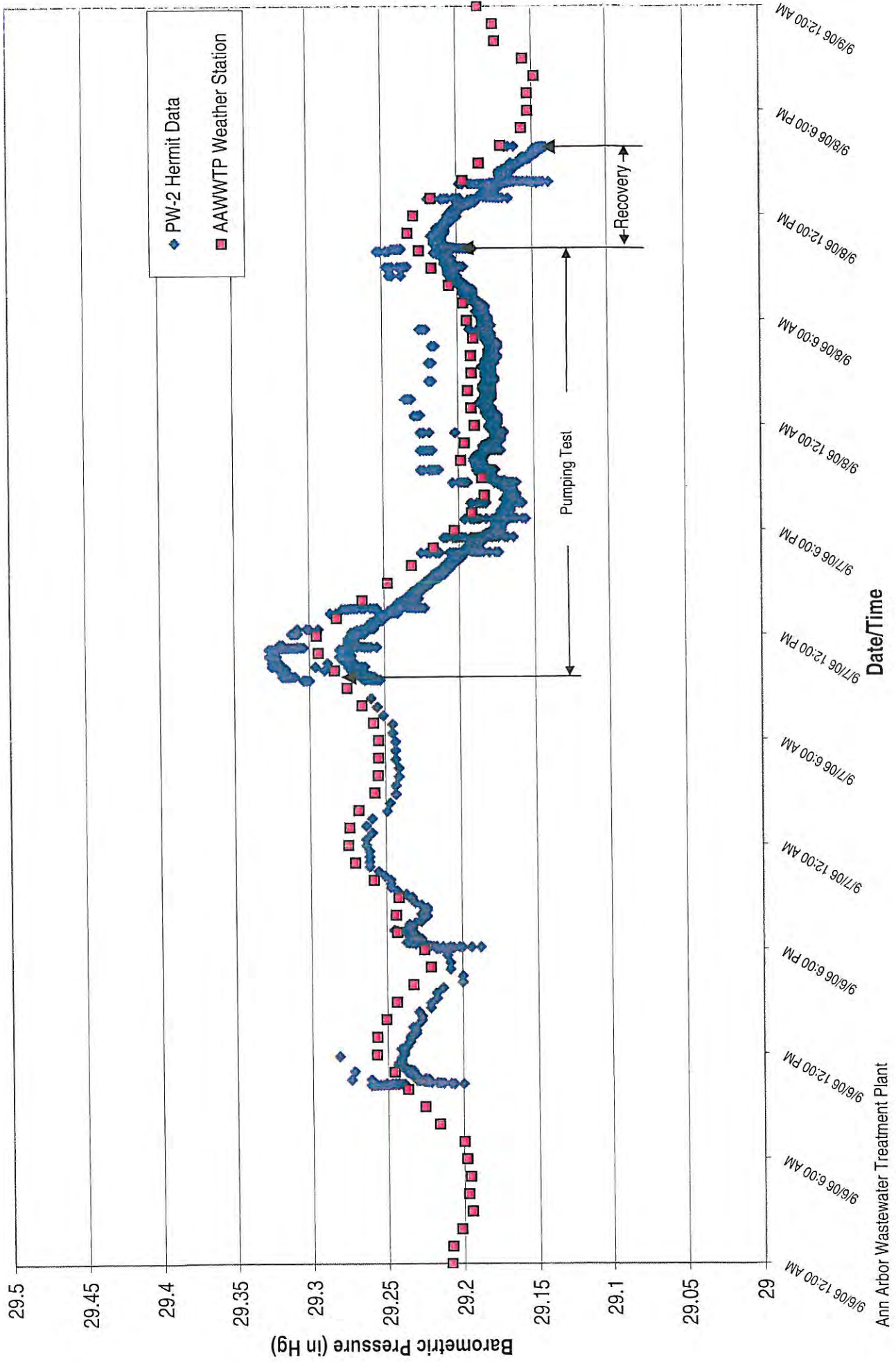


Rain & River Data

Ann Arbor Wastewater Treatment Plant
Ann Arbor, Michigan



BAROMETRIC PRESSURE





APPENDIX D

GROUNDWATER ANALYTICAL DATA:

- **TABLE D-1: SUMMARY OF CHEMICAL ANALYSES**
- **LABORATORY ANALYTICAL REPORTS DATED:**
 - **8/1/06**
 - **8/2/06**
 - **9/7/06**
 - **9/8/06**

SAMPLE ID	SAMPLE DATE	ANTIMONY 7440360	ARSENIC 7440382	BARIUM 7440393	BERYLLIUM 7440417	BORON 7440428	CADMIUM 7440439	TOTAL DISSOLVED SOLIDS (TSS)	MICROBIOLOGICAL ANALYSIS		ORGANIC ANALYSIS (MG/L)			SEMI-VOLATILE ORGANICS [µG/L]	VOLATILE ORGANICS [µG/L]
									FECAL COLIFORM [CFU/100]	IRON BACTERIA	BOD - CARBONACEOUS (CBOD)	PHENOL 108952	CARBON DIOXIDE		
TB-307A ; W-1	07-28-06	----	----	----	----	----	----	----	----	PRESENT	----	----	----	----	----
TB-307A ; W-1	08-01-06	----	----	----	----	----	----	----	----	----	----	75	----	----	
PW-2	08-30-06	ND	ND	0.18	ND	0.03	0.0004	ND	0	----	ND	ND	----	ND	ND
PW-2	09-07-06	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Dup-1	09-07-06	----	----	----	----	----	----	----	----	----	----	----	----	----	----
PW-2 MS	09-07-06	----	----	----	----	----	----	----	----	----	----	----	----	----	----
PW-2 MSD	09-07-06	----	----	----	----	----	----	----	----	----	----	----	----	----	----
FIELD BLANK	09-07-06	----	----	----	----	----	----	----	----	----	----	----	----	----	----
LABORATORY-REPORTED METHOD DETECTION LIMIT		0.002	0.001	0.10	0.001	0.02	0.0002	0.10	1	----	2.0	0.01	1.0	VARIOUS	VARIOUS
PA 451 PART 201 RESIDENTIAL CRITERIA	DW	0.006	0.01	2	0.004	0.50	0.005	0.10	----	----	----	4.4	----	VARIOUS	VARIOUS
	GSI	0.13	0.15	1.2	0.024	1.9	0.0044	0.10	----	----	----	0.21	----	VARIOUS	VARIOUS

NOTES:

- [1] MG/L - MILLIGRAMS PER LITER (≈ PARTS PER MILLION); µG/L - MICROGRAMS PER LITER (≈ PARTS PER BILLION)
- [2] ----- - NOT ANALYZED FOR INDICATED PARAMETER.
- [3] ND - NOT DETECTED AT OR ABOVE LABORATORY-REPORTED METHOD DETECTION LIMIT FOR INDICATED PARAMETER.
- [4] (ID) - INSUFFICIENT DATA.
- [5] (CC) - THE GENERIC GSI CRITERIA ARE BASED ON THE TOXICITY OF UNIONIZED AMMONIA (NH₃); 1.0 MG/L.
- [6] (EE) - DISSOLVED OXYGEN (DO) CRITERIA IS THE MINIMUM LEVEL THAT MUST BE EXCEEDED (7.0 MG/L).
- [7] (FF) - GSI CRITERION SHALL BE 125 MG/L WHEN THE DISCHARGE IS TO SURFACE WATERS OF THE RECEIVING BODY OF WATER.
- [8] * - AESTHETIC-BASED CRITERIA--USE OF THE MOST RESTRICTIVE CRITERIA IS REQUIRED, THEREFORE.
- [9] DW - CONCENTRATION IN GROUNDWATER, IF NOT EXCEEDED, IS CONSIDERED SAFE FOR EXPOSURE TO SURFACE WATERS.
- [10] GSI - PRESENTED ONLY TO ESTABLISH GROUNDWATER CRITERIA WHICH ARE PROTECTIVE OF SURFACE WATERS.
- [11] DWS - CRITERION IS THE STATE OF MICHIGAN DRINKING WATER STANDARD ESTABLISHED PURSUANT TO THE SDWA.



NTH Consultants, Ltd.

Infrastructure Engineering
and Environmental Services

480 Ford Field
2000 Brush Street
Detroit, MI 48226
313.237.3900
313.237.3909 Fax

BAS

Mr. Tom Porter
Malcolm Pirnie, Inc.
645 Griswold Street, Suite 1950
Detroit, Michigan 48226

August 16, 2006
Project No: 15-050510-05

RE: Artesian Well Sampling
Ann Arbor Waste Water Treatment Plant
Ann Arbor, Michigan

Dear Mr. Porter:

NTH Consultants, Ltd. was retained by Malcolm Pirnie, Inc. to collect groundwater samples from an artesian well encountered during geotechnical drilling operations at the above-referenced site. This letter presents the analytical results of the groundwater sampling as well as the results from the field screening conducted during the sampling event.

The water samples were collected directly from Test Boring 307-A on July 28 and August 1, 2006. The first sample set (i.e., July 28) was submitted to Brighton Analytical, LLC (Brighton) for Iron Oxide (as expressed in Total Iron), Hardness, Chloride, Hydrogen Sulfide, Total Dissolved Solids and Iron Bacteria analyses. The second sample set (i.e., August 1) was submitted to RTI Laboratories, Inc. (RTI) for Carbon Dioxide analysis. Please see the attached laboratory data sheets for the analytical results of the groundwater sampling.

Additionally, during the first sampling event, the groundwater was field screened for Dissolved Oxygen (DO) and pH, using the appropriate calibrated meters. The results of the field screening indicated that the levels of DO in the groundwater sample collected from the artesian well ranged between 17.9 and 21.1 percent, and the pH of the groundwater was approximately 7.56.

We are pleased to be of service to you. Should you have any questions or require additional assistance, please feel free to call us.

Sincerely,

NTH Consultants, Ltd.

Beth A. Stearns
Staff Scientist

Joseph B. Alberts, P.E.
Project Manager

BAS/JBA/mam

Attachments



RTI LABORATORIES, INC.

31628 Glendale St.
Livonia, Michigan 48150
TEL: 734.422.8000
FAX: 734.422.5342
Website: www.rtilab.com

August 01, 2006

Beth Stearns
NTH Consultants, Ltd.
38955 Hills Tech Dr
Farmington Hills, MI 48331-3432

TEL: (248) 324-5345
FAX (248) 324-5390

RE: AAWWTP - 15-050510-05

Order No.: 0608020

Dear Beth Stearns:

RTI Laboratories, Inc. received 1 sample(s) on 8/1/2006 for the analyses presented in the following report.

There were no problems with the analytical events associated with this report unless noted in the Case Narrative. Quality control data was within laboratory defined or method specified acceptance limits except if noted.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

A handwritten signature in black ink, appearing to read "Charles O'Bryan", with a long, sweeping underline.

Charles O'Bryan
Director, Quality Management



RTI LABORATORIES, INC.

31628 Glendale St.
Livonia, Michigan 48150
TEL: 734.422.8000
FAX: 734.422.5342
Website: www.rtilab.com

Case Narrative

WO#: 0608020

Date: 8/1/2006

CLIENT: NTH Consultants, Ltd.
Project: AAWWTP - 15-050510-05

This report in its entirety consists of the documents listed below. All documents contain the RTI Work Order Number assigned to this report.

1. Paginated Report including: Case Narrative, Analytical Results and Applicable Quality Control Summary Reports.
2. A Cover Letter that immediately precedes the Paginated Report.
3. Paginated copies of the Chain of Custody Documents supplied with this sample set.

Concentrations reported with a J flag in the Qual field are values below the reporting limit (RL) but greater than the established method detection limit (MDL). There is greater uncertainty associated with these results and data should be considered as estimated.

Concentrations reported with an E flag in the Qual field are values that exceed the upper quantification range. There is greater uncertainty associated with these results and data should be considered as estimated.

Any comments or problems with the analytical events associated with this report are noted below.



RTI LABORATORIES, INC.

31628 Glendale St.
Livonia, Michigan 48150
TEL: 734.422.8000
FAX: 734.422.5342
Website: www.rtilab.com

Analytical Report

(consolidated)

WO#: 0608020

Date Reported: 8/1/2006

CLIENT: NTH Consultants, Ltd.

Collection Date: 8/1/2006 11:00:00 AM

Project: AAWWTP - 15-050510-05

Lab ID: 0608020-001

Matrix: WATER

Client Sample ID TB-307A W-1

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
TOTAL ORGANIC CARBON					E415.2	Analyst: MB2
Carbon dioxide	75	1.0		mg/L	1	8/1/2006

Qualifiers: *X Value exceeds Maximum Contaminant Level
 E Value above quantitation range
 J Analyte detected below quantitation limits
 ND Not Detected at the Reporting Limit
 S Spike Recovery outside accepted recovery limits

B Analyte detected in the associated Method Blank
 H Holding times for preparation or analysis exceeded
 M Manual Integration used to determine area response
 RL Reporting Detection Limit

QC SUMMARY REPORT

CLIENT: NTH Consultants, Ltd.

Work Order: 0608020

Project: AA WWTP - 15-050510-05

TestCode: EPA_415.2-CO2

Sample ID: LCS	SampleType: LCS	TestCode: EPA_415.2-C	Units: mg/L	Prep Date:	RunNo: 7800						
Client ID: LCSW	Batch ID: R7800	TestNo: E415.2		Analysis Date: 8/1/2006	SeqNo: 115671						
Analyte	Result	PQL	SPK value	SPK RefVal	%REC	LowLimit	HighLimit	RPD RefVal	%RPD	RPDLimit	Qual
Carbon dioxide	10	1.0	10.00	0	99.9	80	120				

Sample ID: LCSD	SampleType: LCSD	TestCode: EPA_415.2-C	Units: mg/L	Prep Date:	RunNo: 7800						
Client ID: LCSS02	Batch ID: R7800	TestNo: E415.2		Analysis Date: 8/1/2006	SeqNo: 115672						
Analyte	Result	PQL	SPK value	SPK RefVal	%REC	LowLimit	HighLimit	RPD RefVal	%RPD	RPDLimit	Qual
Carbon dioxide	10	1.0	10.00	0	99.6	80	120	9.989	0.311	25	

Sample ID: MBLK	SampleType: MBLK	TestCode: EPA_415.2-C	Units: mg/L	Prep Date:	RunNo: 7800						
Client ID: PBW	Batch ID: R7800	TestNo: E415.2		Analysis Date: 8/1/2006	SeqNo: 115673						
Analyte	Result	PQL	SPK value	SPK RefVal	%REC	LowLimit	HighLimit	RPD RefVal	%RPD	RPDLimit	Qual
Carbon dioxide	ND	1.0									

Sample ID: dup	SampleType: DUP	TestCode: EPA_415.2-C	Units: mg/L	Prep Date:	RunNo: 7800						
Client ID: ZZZZZZ	Batch ID: R7800	TestNo: E415.2		Analysis Date: 8/1/2006	SeqNo: 115675						
Analyte	Result	PQL	SPK value	SPK RefVal	%REC	LowLimit	HighLimit	RPD RefVal	%RPD	RPDLimit	Qual
Carbon dioxide	76	1.0						74.53	1.44	25	

Qualifiers: E Value above quantitation range
 M Manual Integration used to determine area response
 RL Reporting Detection Limit
 I1 Holding times for preparation or analysis exceeded
 ND Not Detected at the Reporting Limit
 S Spike Recovery outside accepted recovery I
 J Analyte detected below quantitation lin
 R RPD outside accepted recovery limits



RTI LABORATORIES, INC.



A2LA Cert #570.01102



NELAC Cert #000973



MBE Cert #R-8150-2-424



8(a) / SDB

MAIN LAB & HEADQUARTERS
RTI LABORATORIE
31628 Glendale S.
Livonia, MI 48150-1827
Phone (734) 422-8000
Fax (734) 422-5342
www.rtiab.com

Please Include Email Address of Report Recipient Whenever Possible !!!

SMITTING COMPANY: RTI CONSULTANTS
PROJECT #: 15-050510-05
QUOTE #: 6555
SOCIAL INSTRUCTIONS / COMMENTS:

REPORT TO: WPH STEARNS
COMPANY: WPH CONSULTANTS
ADDRESS: 5555 HILLS TOWN DRIVE
CITY, STATE, ZIP: WARMINON HILLS, MI 48324
PHONE: (248) 324-5345
EMAIL (OR FAX IF NO EMAIL AVAILABLE): bstearns@wphconsultants.com

BILL TO: A13
COMPANY:
ADDRESS: SAME
CITY, STATE, ZIP:

P.O. #

SAMPLE ID	DATE SAMPLED	TIME SAMPLED	AIR	SOLID	FLUID	VOLUME	GRAB "G" OR COMPOSITE "C"	NUMBER OF CONTAINERS	ANALYTICAL PARAMETERS	COMMENTS
1	TBS-207A W-1	8/10/06 11:00A						2		Methanol Preserved Weights HOT Sample Notation Additional Sample Description, etc.
2										
3										
4										
5										
6										
7										
8										
9										
10										

REPORT TRANSMITTAL DESIRED:
 HARD COPY (extra cost) FAX EMAIL ONLINE

FOR LAB USE ONLY
 Temp of samples _____ °C On Wet Ice? _____
 Comments: 43

RECEIVED BY: [Signature]
 DATE: 8/10/06 11:50
 TIME: 11:50

RECEIVED BY: [Signature]
 DATE: 8/10/06 11:50
 TIME: 11:50

RECEIVED BY: [Signature]
 DATE: 8/10/06 11:50
 TIME: 11:50

TAT: Standard RUSH: Next BD 2nd BD 3rd BD
 Note: RUSH requests will incur surcharges!

Distribution: White and Yellow - Lab; Pink - Field

See reverse side for Laboratory Terms and Conditions of Service



2105 Pless Drive • Brighton, Michigan 48114 • Phone (810) 229-7575 • Fax (810) 229-8650

August 02, 2006

NTH Consultants, Ltd.
38955 Hills Tech Drive
Farmington Hills, MI 48333-3432

Subject: Ann Arbor WWTP
15-050510-05

Dear Ms. Stearns :

Thank you for making Brighton Analytical, L.L.C. your laboratory of choice. Enclosed are the results for the samples submitted on 07/28/2006 for the above mentioned project. Duplicate copies can be supplied at your request for a fee of \$20.00 per copy.

Enclosed is the invoice for this project. If you have any questions concerning the invoice or the data, please don't hesitate to contact our office. Please reference Brighton Analytical, L.L.C. project ID 88263 when calling with any questions regarding this project.

Sincerely,
Brighton Analytical, L.L.C.

To: NTH Consultants, Ltd.
38955 Hills Tech Drive
Farmington Hills, MI 48333-3432

Sample Date: 07/28/2006
Submit Date: 07/28/2006
Report Date: 08/02/2006

BA Report Number: 88263
BA Sample ID: BM03531

Project Name: Ann Arbor WWTP
Project Number: 15-050510-05
Sample ID: TB-307A W-1

Parameters	Results	Units	DL	Method Reference	Analyst	Analysis Date
Total Metal Analysis						
Total Iron	260	mg/L	0.02	EPA 200.8 rev5.5	GW	07/31/2006
Hardness by Calculation	15000	mg/L	5.0	EPA 200.8 rev5.5	GW	07/31/2006
Metal Water Total (digest)	Digested			3015	PR	07/29/2006
Inorganic Analysis						
Chloride	9.8	mg/L	1.0	SM4500/300	CW	08/01/2006
Hydrogen Sulfide (calc)	Not detected	mg/L	0.006	376.1/4500	RM	08/02/2006
Total Dissolved Solids	360	mg/L	10	EPA 160.1	PR	07/31/2006
Microbiological Analysis						
Iron Bacteria	Present			SM9240	WT	07/28/2006

To: NTH Consultants, Ltd.
38955 Hills Tech Drive
Farmington Hills, MI 48333-3432

Sample Date: 07/28/2006
Submit Date: 07/28/2006
Report Date: 08/02/2006

BA Report Number: **88263**
BA Sample ID: **BM03531**

Project Name: **Ann Arbor WWTP**
Project Number: **15-050510-05**
Sample ID: **TB-307A W-1**

Parameters	Results	Units	DL	Method Reference	Analyst	Analysis Date
------------	---------	-------	----	------------------	---------	---------------

DL=Reported detection limit for analytical method requested. Some compounds require special analytical methods to achieve MDEQ designated target detection limits (TDL).

Released by: *[Signature]*
Date: 8/2/06

BA
 Brighton Analytical, L.L.C.TM
 2105 Pless Drive Phone: 810-229-7575
 Brighton, MI 48114 Fax: 810-229-8650

COMPANY NAME: NTH Consultants
 PROJECT NAME: Ann Arbor WWTP
 PROJECT NUMBER: 15-050510-05
 P. O. NUMBER:

REQUESTED TURNAROUND: (circle one)
 Rush: 1-3 business days (verify with lab & specify date needed)
 Expedited: 5 business days
 Standard: 10 business days

Brighton ID #	Sample Description	IF RUSH, approved by:	
		Time	Date
1) 5531 TB-307A W-12:00 7/18			
2)			
3)			
4)			
5)			
6)			
7)			
8)			
9)			
10)			
11)			

BA PROJECT #: 8263
 ABBREVIATIONS FOR MATRIX:
 S = Solid
 L = Liquid
 DW = Drinking H₂O
 WW = Wastewater
 O = Oil
 P = Wipe
 A = Air (Tedlar Bag)
 F = Filter
 T = Tube
 M = Methanol

Container Type & Quantity		MEOH Preserved (Field or Lab Preferred)
VOA'S (PRES) Y N	HDPE UNPRESERVED	
	HDPE HNO ₃	
	HDPE H ₂ SO ₄	
	HDPE NaOH	
	AMBER	
	GLASS H ₂ SO ₄	
	GLASS, NO PRESERVATIVE	

REPORT RESULTS TO:
 NTH Consultants
 38955 Hills Tech Drive
 Farmington Hills, MI 48333
 Attn: Beth Stearns
 PHONE: 248-324-5345
 FAX: 248-324-5890

Sample received within holding time? yes no

For TCLP ONLY - Federal Limits Other

Samples intact: yes no (if no, see below)

Note samples if not intact:

Headspace/bubbles in VOA'S? yes no n/a

Sample containers and COC match? yes no

Comments:

Temperature of Samples °C: _____

Analysis Requested/Method	FOR DISSOLVED METALS (L) LAB TO FILTER (F) FIELD FILTERED
Sample Matrix	L
Hardness	X
Iron Oxide	X
Hydrogen Sulfide	X
Chloride	X
TOTAL Dissolved Solids	X
Iron bacteria	X

PAGE _____ OF _____

Please fill out the Chain of Custody completely and review. Incorrect or incomplete information will result in a "hold" on all analyses.

Trans. #	RELINQUISHED BY:	RECEIVED BY:	DATE:	TIME:	Trans. #	RELINQUISHED BY:	RECEIVED BY:	DATE:	TIME:
1	Beth Stearns	Beth Stearns	7/28/18	3:00	3				
2					4				

Cannot analyze iron oxide
 Running total iron.
 Client advised. See 8-3-18



BRIGHTON ANALYTICAL, L.L.C.

QUALITY ASSURANCE/QUALITY CONTROL

REPRESENTATIVE BATCH QUALITY CONTROL

Accuracy & Precision

Analyst: PR

Parameter: TDS

Analysis Date: 7/31/2006

Method Reference: 160.1

SPIKE - ACCURACY					
Laboratory ID	Spike Concentration	Background	% Recoveries	Acceptable Range (%)	Method Blank Concentration
ERA	295	<10	100	80 - 120	<10
SPIKE - PRECISION					
Laboratory ID	Observed A	Observed B	RPD	Acceptable Range	
BM03406	6542	6769	3.4	≤20%	
MISCELLANEOUS					
		Standard ID #			
Independent Secondary Reference Material:					

COMMENTS:

METALS QC

- Page 1 – Results of Independent Check Standard
- Page 2 – Percent Recovery of Method Standard (M.STD)
- Page 3 – Percent Recovery of Sample Matrix Spike (MS)
- Page 4 – Percent Recovery of Sample Matrix Spike Duplicate (MSD)
- Page 5 – Relative Percent Difference (RPD) of MS/MSD

Laboratory Control Sample QC Report

Data File: D:\ICPCHEM\1\DATA\06G31s00.B\012_LCS.D\012_LCS.D#
 Date Acquired: Jul 31 2006 07:07 pm
 Acq. Method: EPA.M
 Operator: GJW
 Sample Name: SPEX 1 and 3
 Misc Info:
 Vial Number: 2101
 Current Method: D:\ICPCHEM\1\METHODS\EPA.M
 Calibration File: D:\ICPCHEM\1\CALIB\EPA.C
 Last Cal. Update: Aug 01 2006 09:20 am
 Sample Type: LCS
 Prep Dil. Factor: 100.00
 Autodil Factor: Undiluted
 Final Dil Factor: 100.00

Data Results:
 Analytes: Pass
 ISTD: Pass

Analyte Elements

Element	IS Ref	Tune	Conc. ppb	RSD(%)	Expected	Rec(%)	QC Range(%)	Flag
9 Be	6	3	98.02	0.68	100	98.0	90 - 110	
23 Na	45	2	1956.00	4.19	2000	97.8	90 - 110	
24 Mg	45	2	1998.00	3.87	2000	99.9	90 - 110	
27 Al	45	3	102.90	1.46	100	102.9	90 - 110	
39 K	45	2	1976.00	4.49	2000	98.8	90 - 110	
40 Ca	45	1	1853.00	4.95	2000	92.7	90 - 110	
51 V	89	2	99.67	5.47	100	99.7	90 - 110	
52 Cr	89	2	96.58	5.62	100	96.6	90 - 110	
55 Mn	89	2	95.65	5.86	100	95.7	90 - 110	
56 Fe	89	1	1824.00	3.79	2000	91.2	90 - 110	
59 Co	89	2	97.28	7.06	100	97.3	90 - 110	
60 Ni	89	2	95.92	5.72	100	95.9	90 - 110	
63 Cu	89	2	98.89	5.42	100	98.9	90 - 110	
66 Zn	89	2	96.08	5.57	100	96.1	90 - 110	
75 As	89	2	97.12	5.50	100	97.1	90 - 110	
78 Se	115	1	90.44	4.75	100	90.4	90 - 110	
95 Mo	89	3	107.90	1.29	100	107.9	90 - 110	
106 (Cd)	115	3	101.80	0.59	100	101.8	90 - 110	
107 Ag	115	3	107.50	0.09	100	107.5	90 - 110	
108 (Cd)	115	3	102.00	0.73	100	102.0	90 - 110	
111 Cd	115	3	96.16	0.63	100	96.2	90 - 110	
121 Sb	165	3	101.20	1.07	100	101.2	90 - 110	
137 Ba	159	3	97.70	0.95	100	97.7	90 - 110	
205 Tl	165	3	98.48	0.90	100	98.5	90 - 110	
206 (Pb)	209	3	100.60	0.74	100	100.6	90 - 110	
207 (Pb)	209	3	103.20	0.88	100	103.2	90 - 110	
208 Pb	209	3	95.63	0.89	100	95.6	90 - 110	

ISTD Elements

Element	Tune	CPS Mean	RSD(%)	Ref Value	Rec(%)	QC Range(%)	Flag
6 Li	3	2100671	0.55	2057489	102.1	65 - 125	
7 (Li)	3	110962	0.32	108650	102.1	65 - 125	
45 Sc	1	1641026	4.74	1444145	113.6	65 - 125	
45 Sc	2	273487	3.79	277178	98.7	65 - 125	
45 Sc	3	4969622	1.54	4892933	101.6	65 - 125	
89 Y	1	4590740	4.37	3970867	115.6	65 - 125	
89 Y	2	1174010	4.82	1187849	98.8	65 - 125	
89 Y	3	7282134	0.32	7254988	100.4	65 - 125	
115 In	1	4749280	4.42	4108773	115.6	65 - 125	
115 In	2	1266782	5.65	1307599	96.9	65 - 125	
115 In	3	6433018	0.83	6467079	99.5	65 - 125	
118 (In)	1	937	3.92	748	125.4	65 - 125	
118 (In)	2	308	3.07	256	120.2	65 - 125	
118 (In)	3	1279	6.70	1126	113.6	65 - 125	
159 Tb	3	7001288	1.19	7065877	99.1	65 - 125	
165 Ho	3	6623081	1.88	6630791	99.9	65 - 125	
209 Bi	3	3053948	1.22	3123602	97.8	65 - 125	

Tune File# 1 d:\icpchem\1\7500\h2.u
 Tune File# 2 d:\icpchem\1\7500\he.u
 Tune File# 3 d:\icpchem\1\7500\no gas.u

ISTD Ref File : D:\ICPCHEM\1\DATA\06G31s00.B\003CALB.D\003CALB.D#

0 :Element Failures 0 :Max. Number of Failures Allowed
 0 :ISTD Failures 0 :Max. Number of ISTD Failures Allowed

Laboratory Fortified Blank QC Report

ata File: D:\ICPCHEM\1\DATA\06G31s00.B\017_LFB.D\017_LFB.D#
 Date Acquired: Jul 31 2006 07:34 pm
 Acq. Method: EPA.M
 Operator: GJW
 Sample Name: M. STD. 07-27-06
 Misc Info: TOTAL WATER
 Vial Number: 2106
 Current Method: D:\ICPCHEM\1\METHODS\EPA.M
 Calibration File: D:\ICPCHEM\1\CALIB\EPA.C
 Last Cal. Update: Aug 01 2006 09:20 am
 Sample Type: LFB
 Prep Dil. Factor: 10.00
 Autodil Factor: Undiluted
 Final Dil Factor: 10.00

Data Results:
 Analytes: Fail
 ISTD: Pass

DK - SET FOR AS ONLY

Analyte Elements

Element	IS Ref	Tune	Conc. ppb	RSD(%)	Expected	Rec(%)	QC Range(%)	Flag
9 Be	6	3	233.40	1.41	200	116.7	80 - 120	
23 Na	45	2	1948.00	0.37	2000	97.4	80 - 120	
24 Mg	45	2	1965.00	0.91	2000	98.3	80 - 120	
27 Al	45	3	179.60	0.70	200	89.8	80 - 120	
39 K	45	2	1957.00	1.29	2000	97.9	80 - 120	
40 Ca	45	1	2048.00	2.50	2000	102.4	80 - 120	
51 V	89	2	236.50	0.38	200	118.3	80 - 120	
52 Cr	89	2	225.60	0.61	200	112.8	80 - 120	
55 Mn	89	2	228.30	0.75	200	114.2	80 - 120	
56 Fe	89	1	2021.00	1.08	2000	101.1	80 - 120	
59 Co	89	2	186.10	0.71	200	93.1	80 - 120	
60 Ni	89	2	188.40	0.71	200	94.2	80 - 120	
3 Cu	89	2	236.40	0.27	200	118.2	80 - 120	
66 Zn	89	2	185.20	0.70	200	92.6	80 - 120	
75 As	89	2	195.90	0.74	200	98.0	80 - 120	
78 Se	115	1	198.50	1.43	200	99.3	80 - 120	
95 Mo	89	3	215.60	0.31	200	107.8	80 - 120	
107 Ag	115	3	1.70	1.89	2	85.1	80 - 120	
111 Cd	115	3	243.00	1.07	200	121.5	80 - 120	Fail
121 Sb	165	3	199.70	0.42	200	99.9	80 - 120	
137 Ba	159	3	243.70	0.79	200	121.9	80 - 120	Fail
205 Tl	165	3	192.40	0.69	200	96.2	80 - 120	
208 Pb	209	3	214.90	0.66	200	107.5	80 - 120	

ISTD Elements

Element	Tune	CPS Mean	RSD(%)	Ref Value	Rec(%)	QC Range(%)	Flag
6 Li	3	2106832	0.87	2057489	102.4	65 - 125	
45 Sc	1	1495924	1.29	1444145	103.6	65 - 125	
45 Sc	2	280629	0.57	277178	101.2	65 - 125	
45 Sc	3	5058318	0.08	4892933	103.4	65 - 125	
89 Y	1	4226995	0.72	3970867	106.5	65 - 125	
89 Y	2	1211939	0.73	1187849	102.0	65 - 125	
89 Y	3	7445191	0.69	7254988	102.6	65 - 125	
115 In	1	4362545	0.90	4108773	106.2	65 - 125	
115 In	2	1311467	1.80	1307599	100.3	65 - 125	
115 In	3	6595906	1.39	6467079	102.0	65 - 125	
159 Tb	3	7174591	1.34	7065877	101.5	65 - 125	
165 Ho	3	6748899	1.18	6630791	101.8	65 - 125	
209 Bi	3	3127128	1.26	3123602	100.1	65 - 125	

Tune File# 1 d:\icpchem\1\7500\h2.u
 Tune File# 2 d:\icpchem\1\7500\he.u
 Tune File# 3 d:\icpchem\1\7500\no_gas.u

ISTD Ref File : D:\ICPCHEM\1\DATA\06G31s00.B\003CALB.D\003CALB.D#

2 :Element Failures 0 :Max. Number of Failures Allowed
 0 :ISTD Failures 0 :Max. Number of ISTD Failures Allowed

Laboratory Fortified Matrix QC Report

a File: D:\ICPCHEM\1\DATA\06G31s00.B\024LFM2.D\024LFM2.D#
 Date Acquired: Jul 31 2006 08:11 pm
 Acq. Method: EPA.M
 Operator: GJW
 Sample Name: BM03068 MS
 Misc Info: TOTAL WATER
 Vial Number: 2111
 Current Method: D:\ICPCHEM\1\METHODS\EPA.M
 Calibration File: D:\ICPCHEM\1\CALIB\EPA.C
 Last Cal. Update: Aug 01 2006 09:20 am
 Sample Type: LFM2
 Prep Dil. Factor: 10.00
 Autodil Factor: Undiluted
 Final Dil Factor: 10.00

Data Results:
 Analytes: Fail
 ISTD: Pass

Spike Ref. File: D:\ICPCHEM\1\DATA\06G31s00.B\021LFMR.D\021LFMR.D#

QC Elements

Element	IS Ref	Tune	Conc. ppb	Ref Conc	RSD(%)	Spk Amt	Rec(%)	QC Range(%)	QC Flag
9 Be	6	3	236.80	0.03	0.67	200.00	118.39	80 - 120	
23 Na	45	2	2446.00	489.30	7.60	2000.00	97.84	80 - 120	
24 Mg	45	2	5043.00	2934.00	9.45	2000.00	105.45	80 - 120	
27 Al	45	3	181.80	1.97	0.96	200.00	89.92	80 - 120	
39 K	45	2	2179.00	96.59	8.16	2000.00	104.12	80 - 120	
40 Ca	45	1	10290.00	8094.00	1.58	2000.00	109.80	80 - 120	SPAmtLow
51 V	89	2	254.90	0.06	8.25	200.00	127.42	80 - 120	Fail
52 Cr	89	2	243.80	0.59	8.74	200.00	121.61	80 - 120	Fail
55 Mn	89	2	248.40	3.49	9.41	200.00	122.46	80 - 120	Fail
56 Fe	89	1	2067.00	3.43	1.00	2000.00	103.18	80 - 120	
59 Co	89	2	198.40	0.06	8.73	200.00	99.17	80 - 120	
60 Ni	89	2	200.00	0.66	8.86	200.00	99.67	80 - 120	
63 Cu	89	2	248.90	0.60	9.56	200.00	124.15	80 - 120	Fail
66 Zn	89	2	205.30	6.81	8.91	200.00	99.24	80 - 120	
75 As	89	2	212.10	0.14	9.09	200.00	105.98	80 - 120	
78 Se	115	1	203.60	0.11	0.64	200.00	101.74	80 - 120	
95 Mo	89	3	218.30	0.32	0.38	200.00	108.99	80 - 120	
107 Ag	115	3	1.74	0.00	2.17	2.00	86.62	80 - 120	
111 Cd	115	3	247.40	-0.02	1.20	200.00	123.71	80 - 120	Fail
121 Sb	165	3	205.70	0.07	0.57	200.00	102.82	80 - 120	
137 Ba	159	3	254.20	5.19	0.38	200.00	124.50	80 - 120	Fail
205 Tl	165	3	197.00	0.04	1.34	200.00	98.48	80 - 120	
208 Pb	209	3	217.00	0.05	0.18	200.00	108.47	80 - 120	

ISTD Elements

Element	Tune	Counts	RSD(%)	Ref. Counts	Rec(%)	QC Range(%)	QC Flag
6 Li	3	2101378	0.64	2057489	102.1	65 - 125	
7 (Li)	3	125798	0.44	108650	115.8	65 - 125	
45 Sc	1	1515739	1.81	1444145	105.0	65 - 125	
45 Sc	2	271059	7.82	277178	97.8	65 - 125	
45 Sc	3	5014583	0.55	4892933	102.5	65 - 125	
89 Y	1	4269691	1.22	3970867	107.5	65 - 125	
89 Y	2	1146000	7.71	1187849	96.5	65 - 125	
89 Y	3	7401549	0.90	7254988	102.0	65 - 125	
115 In	1	4405386	1.21	4108773	107.2	65 - 125	
115 In	2	1174290	18.94	1307599	89.8	65 - 125	
115 In	3	6509676	1.56	6467079	100.7	65 - 125	
118 (In)	1	800	3.89	748	106.9	65 - 125	
118 (In)	2	244	7.06	256	95.2	65 - 125	
118 (In)	3	1071	1.18	1126	95.2	65 - 125	
159 Tb	3	7099178	1.31	7065877	100.5	65 - 125	
165 Ho	3	6648421	1.42	6630791	100.3	65 - 125	
209 Bi	3	3091518	1.37	3123602	99.0	65 - 125	

Tune File# 1 d:\icpchem\1\7500\h2.u
 Tune File# 2 d:\icpchem\1\7500\he.u
 Tune File# 3 d:\icpchem\1\7500\no gas.u

ISTD Ref File : D:\ICPCHEM\1\DATA\06G31s00.B\003CALB.D\003CALB.D#

1 :Element Failures 0 :Max. Number of Failures Allowed
 0 :ISTD Failures 0 :Max. Number of ISTD Failures Allowed

Laboratory Fortified Matrix QC Report

Data File: D:\ICPCHEM\1\DATA\06G31s00.B\025LFM2.D\025LFM2.D#
 Date Acquired: Jul 31 2006 08:16 pm
 Acq. Method: EPA.M
 Operator: GJW
 Sample Name: BM03368 MSD
 Misc Info: TOTAL WATER
 Vial Number: 2112
 Current Method: D:\ICPCHEM\1\METHODS\EPA.M
 Calibration File: D:\ICPCHEM\1\CALIB\EPA.C
 Last Cal. Update: Aug 01 2006 09:20 am
 Sample Type: LFM2
 Prep Dil. Factor: 10.00
 Autodil Factor: Undiluted
 Final Dil Factor: 10.00

Data Results:
 Analytes: Fail
 ISTD: Pass

Spike Ref. File: D:\ICPCHEM\1\DATA\06G31s00.B\021LFMR.D\021LFMR.D#

QC Elements

Element	IS Ref	Tune	Conc. ppb	Ref Conc	RSD(%)	Spk Amt	Rec(%)	QC Range(%)	QC Flag
9 Be	6	3	236.50	0.03	8.03	200.00	118.24	80 - 120	
23 Na	45	2	2369.00	489.30	1.13	2000.00	93.99	80 - 120	
24 Mg	45	2	4893.00	2934.00	0.28	2000.00	97.95	80 - 120	
27 Al	45	3	177.90	1.97	9.17	200.00	87.97	80 - 120	
39 K	45	2	2116.00	96.59	0.59	2000.00	100.97	80 - 120	
40 Ca	45	1	10360.00	8094.00	1.42	2000.00	113.30	80 - 120	SPAmtLow
51 V	89	2	246.20	0.06	0.51	200.00	123.07	80 - 120	Fail
52 Cr	89	2	233.20	0.59	0.46	200.00	116.31	80 - 120	
55 Mn	89	2	240.60	3.49	0.33	200.00	118.56	80 - 120	
56 Fe	89	1	2097.00	3.43	0.29	2000.00	104.68	80 - 120	
59 Co	89	2	190.40	0.06	0.57	200.00	95.17	80 - 120	
60 Ni	89	2	192.50	0.66	0.76	200.00	95.92	80 - 120	
63 Cu	89	2	239.80	0.60	0.89	200.00	119.60	80 - 120	
66 Zn	89	2	197.60	6.81	0.80	200.00	95.39	80 - 120	
75 As	89	2	204.50	0.14	0.59	200.00	102.18	80 - 120	
78 Se	115	1	208.00	0.11	0.72	200.00	103.94	80 - 120	
95 Mo	89	3	216.10	0.32	10.36	200.00	107.89	80 - 120	
107 Ag	115	3	1.69	0.00	11.28	2.00	84.32	80 - 120	
111 Cd	115	3	239.90	-0.02	10.52	200.00	119.96	80 - 120	
121 Sb	165	3	199.70	0.07	10.69	200.00	99.82	80 - 120	
137 Ba	159	3	249.70	5.19	9.82	200.00	122.25	80 - 120	Fail
205 Tl	165	3	190.80	0.04	10.13	200.00	95.38	80 - 120	
208 Pb	209	3	213.40	0.05	9.93	200.00	106.67	80 - 120	

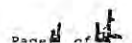
ISTD Elements

Element	Tune	Counts	RSD(%)	Ref. Counts	Rec(%)	QC Range(%)	QC Flag
6 Li	3	2177616	7.18	2057489	105.8	65 - 125	
7 (Li)	3	131874	6.21	108650	121.4	65 - 125	
45 Sc	1	1538457	1.50	1444145	106.5	65 - 125	
45 Sc	2	285964	0.17	277178	103.2	65 - 125	
45 Sc	3	5310471	9.26	4892933	108.5	65 - 125	
89 Y	1	4326711	1.03	3970867	109.0	65 - 125	
89 Y	2	1215946	0.40	1187849	102.4	65 - 125	
89 Y	3	7781448	9.24	7254988	107.3	65 - 125	
115 In	1	4449300	1.10	4108773	108.3	65 - 125	
115 In	2	1312803	0.32	1307599	100.4	65 - 125	
115 In	3	6902384	10.07	6467079	106.7	65 - 125	
118 (In)	1	814	2.98	748	108.8	65 - 125	
118 (In)	2	265	4.62	256	103.3	65 - 125	
118 (In)	3	1130	6.19	1126	100.4	65 - 125	
159 Tb	3	7450632	9.88	7065877	105.4	65 - 125	
165 Ho	3	6987944	9.84	6630791	105.4	65 - 125	
209 Bi	3	3192711	8.78	3123602	102.2	65 - 125	

Tune File# 1 d:\icpchem\1\7500\h2.u
 Tune File# 2 d:\icpchem\1\7500\he.u
 Tune File# 3 d:\icpchem\1\7500\no gas.u

ISTD Ref File : D:\ICPCHEM\1\DATA\06G31s00.B\003CALB.D\003CALB.D#

1 :Element Failures 0 :Max. Number of Failures Allowed
 0 :ISTD Failures 0 :Max. Number of ISTD Failures Allowed



Duplicate Sample QC Report

File: D:\ICPCHEM\1\DATA\06G31s00.B\025LFM2.D\025LFM2.D#
 Acquired: Jul 31 2006 08:16 pm
 Method: EPA.M
 Operator: GJW
 Sample Name: BM03368 MSD
 Misc Info: TOTAL WATER
 Vial Number: 2112
 Current Method: D:\ICPCHEM\1\METHODS\EPA.M
 Calibration File: D:\ICPCHEM\1\CALIB\EPA.C
 Last Cal. Update: Aug 01 2006 10:49 am
 Sample Type: Dup2
 Dilution Factor: 1.00

Data Results:
 Analytes: Fail
 ISTD: Pass

Duplicate Ref File: D:\ICPCHEM\1\DATA\06G31s00.B\024LFM2.D\024LFM2.D#

QC Elements

Element	IS Ref	Tune	Conc.	RSD(%)	Ref Conc	Differ(%)	High Limit	Flag
9 Be	6	3	236.50 ug/l	8.03	236.80	0.13	4	
23 Na	45	2	2369.00 ug/l	1.13	2446.00	3.20	4	<3*IDL
24 Mg	45	2	4893.00 ug/l	0.28	5043.00	3.02	4	
27 Al	45	3	177.90 ug/l	9.17	181.80	2.17	4	<3*IDL
39 K	45	2	2116.00 ug/l	0.59	2179.00	2.93	4	<3*IDL
40 Ca	45	1	10360.00 ug/l	1.42	10290.00	0.68	4	
51 V	89	2	246.20 ug/l	0.51	254.90	3.47	4	
52 Cr	89	2	233.20 ug/l	0.46	243.80	4.44	4	
55 Mn	89	2	240.60 ug/l	0.33	248.40	3.19	4	
56 Fe	89	1	2097.00 ug/l	0.29	2067.00	1.44	4	<3*IDL
59 Co	89	2	190.40 ug/l	0.57	198.40	4.12	4	
60 Ni	89	2	192.50 ug/l	0.76	200.00	3.82	4	
63 Cu	89	2	239.80 ug/l	0.89	248.90	3.72	4	
66 Zn	89	2	197.60 ug/l	0.80	205.30	3.82	4	
75 As	89	2	204.50 ug/l	0.59	212.10	3.65	4	
78 Se	115	1	208.00 ug/l	0.72	203.60	2.14	4	
95 Mo	89	3	216.10 ug/l	10.36	218.30	1.01	4	
106 (Cd)	115	3	206.90 ug/l	11.81	212.70	2.76	4	
107 Ag	115	3	1.69 ug/l	11.28	1.74	2.68	4	<3*IDL
(Cd)	115	3	206.50 ug/l	10.89	212.90	3.05	4	
1 Cd	115	3	239.90 ug/l	10.52	247.40	3.08	4	
121 Sb	165	3	199.70 ug/l	10.69	205.70	2.96	4	
137 Ba	159	3	249.70 ug/l	9.82	254.20	1.79	4	
205 Tl	165	3	190.80 ug/l	10.13	197.00	3.20	4	
206 (Pb)	209	3	263.70 ug/l	9.39	267.60	1.47	4	
207 (Pb)	209	3	261.90 ug/l	9.13	265.30	1.29	4	
208 Pb	209	3	213.40 ug/l	9.93	217.00	1.67	4	

ISTD Elements

Element	Tune	CPS Mean	RSD(%)	Ref Value	Rec(%)	QC Range(%)	Flag
6 Li	3	2177616	7.18	2057489	105.8	65 - 125	
7 (Li)	3	131874	6.21	108650	121.4	65 - 125	
45 Sc	1	1538457	1.50	1444145	106.5	65 - 125	
45 Sc	2	285964	0.17	277178	103.2	65 - 125	
45 Sc	3	5310471	9.26	4892933	108.5	65 - 125	
89 Y	1	4326711	1.03	3970867	109.0	65 - 125	
89 Y	2	1215946	0.40	1187849	102.4	65 - 125	
89 Y	3	7781448	9.24	7254988	107.3	65 - 125	
115 In	1	4449300	1.10	4108773	108.3	65 - 125	
115 In	2	1312803	0.32	1307599	100.4	65 - 125	
115 In	3	6902384	10.07	6467079	106.7	65 - 125	
118 (In)	1	814	2.98	748	108.8	65 - 125	
118 (In)	2	265	4.62	256	103.3	65 - 125	
118 (In)	3	1130	6.19	1126	100.4	65 - 125	
159 Tb	3	7450632	9.88	7065877	105.4	65 - 125	
165 Ho	3	6987944	9.84	6630791	105.4	65 - 125	
209 Bi	3	3192711	8.78	3123602	102.2	65 - 125	

Tune File# 1 d:\icpchem\1\7500\h2.u
 Tune File# 2 d:\icpchem\1\7500\he.u
 Tune File# 3 d:\icpchem\1\7500\no gas.u

ISTD Ref. File : D:\ICPCHEM\1\DATA\06G31s00.B\003CALB.D\003CALB.D#

F : Element Failures 0 :Max. Number of Failures Allowed
 J : ISTD Failures 0 :Max. Number of ISTD Failures Allowed

Laboratory Fortified Blank QC Report

ata File: D:\ICPCHEM\1\DATA\06G31s00.B\030_LFB.D\030_LFB.D#
 Date Acquired: Jul 31 2006 08:43 pm
 Acq. Method: EPA.M
 Operator: GJW
 Sample Name: M. STD. 07-28-06
 Misc Info: TOTAL WATER
 Vial Number: 2202
 Current Method: D:\ICPCHEM\1\METHODS\EPA.M
 Calibration File: D:\ICPCHEM\1\CALIB\EPA.C
 Last Cal. Update: Aug 01 2006 12:26 pm
 Sample Type: LFB
 Prep Dil. Factor: 10.00
 Autodil Factor: Undiluted
 Final Dil Factor: 10.00

Data Results:

Analytes: Pass
 ISTD: Pass

Analyte Elements

Element	IS Ref	Tune	Conc. ppb	RSD(%)	Expected	Rec(%)	QC Range(%)	Flag
9 Be	6	3	208.60	1.01	200	104.3	80 - 120	
23 Na	45	2	1858.00	2.22	2000	92.9	80 - 120	
24 Mg	45	2	1907.00	2.57	2000	95.4	80 - 120	
27 Al	45	3	179.20	0.27	200	89.6	80 - 120	
39 K	45	2	1892.00	1.75	2000	94.6	80 - 120	
40 Ca	45	1	2066.00	0.56	2000	103.3	80 - 120	
51 V	89	2	220.30	2.78	200	110.2	80 - 120	
52 Cr	89	2	215.20	1.95	200	107.6	80 - 120	
55 Mn	89	2	219.60	1.85	200	109.8	80 - 120	
56 Fe	89	1	2026.00	1.26	2000	101.3	80 - 120	
59 Co	89	2	193.00	2.02	200	96.5	80 - 120	
60 Ni	89	2	196.20	1.95	200	98.1	80 - 120	
63 Cu	89	2	219.40	2.16	200	109.7	80 - 120	
66 Zn	89	2	183.50	1.98	200	91.8	80 - 120	
75 As	89	2	192.40	1.93	200	96.2	80 - 120	
78 Se	115	1	200.80	0.99	200	100.4	80 - 120	
95 Mo	89	3	223.40	0.42	200	111.7	80 - 120	
107 Ag	115	3	1.85	1.06	2	92.5	80 - 120	
111 Cd	115	3	229.60	0.82	200	114.8	80 - 120	
121 Sb	165	3	198.70	1.90	200	99.4	80 - 120	
137 Ba	159	3	221.20	0.43	200	110.6	80 - 120	
205 Tl	165	3	192.70	1.65	200	96.4	80 - 120	
208 Pb	209	3	197.90	0.66	200	99.0	80 - 120	

ISTD Elements

Element	Tune	CPS Mean	RSD(%)	Ref Value	Rec(%)	QC Range(%)	Flag
6 Li	3	2110734	0.68	2187971	96.5	65 - 125	
45 Sc	1	1528420	0.52	1508375	101.3	65 - 125	
45 Sc	2	294065	1.93	284063	103.5	65 - 125	
45 Sc	3	5030896	0.66	5238429	96.0	65 - 125	
89 Y	1	4326910	1.09	4235101	102.2	65 - 125	
89 Y	2	1248103	2.05	1223523	102.0	65 - 125	
89 Y	3	7435079	0.53	7750993	95.9	65 - 125	
115 In	1	4474546	0.89	4390255	101.9	65 - 125	
115 In	2	1352676	2.84	1344115	100.6	65 - 125	
115 In	3	6527810	0.07	6947332	94.0	65 - 125	
159 Tb	3	7160528	0.91	7525543	95.1	65 - 125	
165 Ho	3	6715380	1.51	7041058	95.4	65 - 125	
209 Bi	3	3103158	2.06	3329882	93.2	65 - 125	

Tune File# 1 d:\icpchem\1\7500\h2.u
 Tune File# 2 d:\icpchem\1\7500\he.u
 Tune File# 3 d:\icpchem\1\7500\no_gas.u

ISTD Ref File : D:\ICPCHEM\1\DATA\06G31s00.B\028SMPL.D\028SMPL.D#

0 :Element Failures
 0 :ISTD Failures

0 :Max. Number of Failures Allowed
 0 :Max. Number of ISTD Failures Allowed

Laboratory Fortified Matrix QC Report

a File: D:\ICPCHEM\1\DATA\06G31s00.B\037LFM2.D\037LFM2.D#
 e Acquired: Jul 31 2006 09:20 pm
 Acq. Method: EPA.M
 Operator: GJW
 Sample Name: BM03401 MS
 Misc Info: TOTAL WATER
 Vial Number: 2207
 Current Method: D:\ICPCHEM\1\METHODS\EPA.M
 Calibration File: D:\ICPCHEM\1\CALIB\EPA.C
 Last Cal. Update: Aug 01 2006 12:26 pm
 Sample Type: LFM2
 Prep Dil. Factor: 10.00
 Autodil Factor: Undiluted
 Final Dil Factor: 10.00

Data Results:
 Analytes: Fail
 ISTD: Pass

Spike Ref. File: D:\ICPCHEM\1\DATA\06G31s00.B\036LFMR.D\036LFMR.D#

QC Elements

Element	IS Ref	Tune	Conc. ppb	Ref Conc	RSD(%)	Spk Amt	Rec(%)	QC Range(%)	QC Flag
9 Be	6	3	212.00	-0.08	5.31	200.00	106.04	80 - 120	
23 Na	45	2	3379.00	1416.00	0.62	2000.00	98.15	80 - 120	
24 Mg	45	2	4133.00	2221.00	0.25	2000.00	95.60	80 - 120	
27 Al	45	3	196.60	1.98	7.39	200.00	97.31	80 - 120	
39 K	45	2	2174.00	133.00	0.29	2000.00	102.05	80 - 120	
40 Ca	45	1	9806.00	7539.00	1.16	2000.00	113.35	80 - 120	SPAmtLow
51 V	89	2	233.30	-0.02	0.27	200.00	116.66	80 - 120	
52 Cr	89	2	226.70	0.01	1.12	200.00	113.34	80 - 120	
55 Mn	89	2	236.70	2.57	0.58	200.00	117.07	80 - 120	
56 Fe	89	1	2219.00	115.20	0.14	2000.00	105.19	80 - 120	
59 Co	89	2	201.80	0.01	0.88	200.00	100.90	80 - 120	
60 Ni	89	2	203.90	0.07	0.61	200.00	101.92	80 - 120	
63 Cu	89	2	228.10	1.24	1.05	200.00	113.43	80 - 120	
66 Zn	89	2	200.50	7.66	0.60	200.00	96.42	80 - 120	
75 As	89	2	203.80	1.39	0.92	200.00	101.20	80 - 120	
78 Se	115	1	205.40	-0.01	0.65	200.00	102.70	80 - 120	
15 Mo	89	3	233.00	0.31	6.90	200.00	116.35	80 - 120	
107 Ag	115	3	1.88	0.00	7.35	2.00	93.78	80 - 120	
111 Cd	115	3	231.80	-0.07	7.16	200.00	115.94	80 - 120	
121 Sb	165	3	206.60	-0.06	6.33	200.00	103.33	80 - 120	
137 Ba	159	3	247.80	15.94	6.39	200.00	115.93	80 - 120	
205 Tl	165	3	196.20	-0.07	7.14	200.00	98.14	80 - 120	
208 Pb	209	3	203.50	0.16	6.38	200.00	101.67	80 - 120	

ISTD Elements

Element	Tune	Counts	RSD(%)	Ref. Counts	Rec(%)	QC Range(%)	QC Flag
6 Li	3	2165204	4.93	2187971	99.0	65 - 125	
7 (Li)	3	129668	3.70	117566	110.3	65 - 125	
45 Sc	1	1524945	0.81	1508375	101.1	65 - 125	
45 Sc	2	282718	0.93	284063	99.5	65 - 125	
45 Sc	3	5138469	6.18	5238429	98.1	65 - 125	
89 Y	1	4283564	0.29	4235101	101.1	65 - 125	
89 Y	2	1196327	1.32	1223523	97.8	65 - 125	
89 Y	3	7550088	5.59	7750993	97.4	65 - 125	
115 In	1	4408497	0.44	4390255	100.4	65 - 125	
115 In	2	1300987	1.31	1344115	96.8	65 - 125	
115 In	3	6612788	6.56	6947332	95.2	65 - 125	
118 (In)	1	15485	1.02	640	2419.4	65 - 125	
118 (In)	2	4963	2.34	213	2330.4	65 - 125	
118 (In)	3	20982	0.58	902	2325.4	65 - 125	
159 Tb	3	7136486	5.36	7525543	94.8	65 - 125	
165 Ho	3	6657270	5.74	7041058	94.5	65 - 125	
209 Bi	3	3043939	5.50	3329882	91.4	65 - 125	

Tune File# 1 d:\icpchem\1\7500\h2.u
 Tune File# 2 d:\icpchem\1\7500\he.u
 Tune File# 3 d:\icpchem\1\7500\no gas.u

ISTD Ref File : D:\ICPCHEM\1\DATA\06G31s00.B\028SMPL.D\028SMPL.D#

1 :Element Failures 0 :Max. Number of Failures Allowed
 0 :ISTD Failures 0 :Max. Number of ISTD Failures Allowed

Laboratory Fortified Matrix QC Report

File: D:\ICPCHEM\1\DATA\06G31s00.B\038LFM2.D\038LFM2.D#
 Date Acquired: Jul 31 2006 09:25 pm
 Acq. Method: EPA.M
 Operator: GJW
 Sample Name: BM03401 MSD
 Misc Info: TOTAL WATER
 Vial Number: 2208
 Current Method: D:\ICPCHEM\1\METHODS\EPA.M
 Calibration File: D:\ICPCHEM\1\CALIB\EPA.C
 Last Cal. Update: Aug 01 2006 12:26 pm
 Sample Type: LFM2
 Prep Dil. Factor: 10.00
 Autodil Factor: Undiluted
 Final Dil Factor: 10.00

Data Results:
 Analytes: Fail
 ISTD: Pass

Spike Ref. File: D:\ICPCHEM\1\DATA\06G31s00.B\036LFMR.D\036LFMR.D#

QC Elements

Element	IS Ref	Tune	Conc. ppb	Ref Conc	RSD(%)	Spk Amt	Rec(%)	QC Range(%)	QC Flag
9 Be	6	3	210.00	-0.08	0.45	200.00	105.04	80 - 120	
23 Na	45	2	3308.00	1416.00	0.72	2000.00	94.60	80 - 120	
24 Mg	45	2	4024.00	2221.00	1.56	2000.00	90.15	80 - 120	
27 Al	45	3	206.50	1.98	0.42	200.00	102.26	80 - 120	
39 K	45	2	2150.00	133.00	1.01	2000.00	100.85	80 - 120	
40 Ca	45	1	11490.00	7539.00	13.91	2000.00	197.55	80 - 120	SPAmtLow
51 V	89	2	230.60	-0.02	2.81	200.00	115.31	80 - 120	
52 Cr	89	2	224.80	0.01	3.64	200.00	112.39	80 - 120	
55 Mn	89	2	233.00	2.57	3.40	200.00	115.22	80 - 120	
56 Fe	89	1	2559.00	115.20	13.94	2000.00	122.19	80 - 120	Fail
59 Co	89	2	198.40	0.01	2.48	200.00	99.20	80 - 120	
60 Ni	89	2	200.80	0.07	2.84	200.00	100.37	80 - 120	
63 Cu	89	2	225.60	1.24	2.81	200.00	112.18	80 - 120	
66 Zn	89	2	199.70	7.66	2.48	200.00	96.02	80 - 120	
75 As	89	2	201.50	1.39	2.19	200.00	100.05	80 - 120	
78 Se	115	1	237.40	-0.01	13.23	200.00	118.70	80 - 120	
75 Mo	89	3	230.30	0.31	0.64	200.00	115.00	80 - 120	
77 Ag	115	3	1.85	0.00	0.75	2.00	92.43	80 - 120	
111 Cd	115	3	227.30	-0.07	1.06	200.00	113.69	80 - 120	
121 Sb	165	3	204.20	-0.06	2.13	200.00	102.13	80 - 120	
137 Ba	159	3	245.40	15.94	1.75	200.00	114.73	80 - 120	
205 Tl	165	3	191.40	-0.07	1.22	200.00	95.74	80 - 120	
208 Pb	209	3	199.90	0.16	0.63	200.00	99.87	80 - 120	

ISTD Elements

Element	Tune	Counts	RSD(%)	Ref. Counts	Rec(%)	QC Range(%)	QC Flag
6 Li	3	2135215	0.55	2187971	97.6	65 - 125	
7 (Li)	3	130855	0.91	117566	111.3	65 - 125	
45 Sc	1	1394662	13.44	1508375	92.5	65 - 125	
45 Sc	2	291503	0.94	284063	102.6	65 - 125	
45 Sc	3	5132345	0.55	5238429	98.0	65 - 125	
89 Y	1	3894524	12.81	4235101	92.0	65 - 125	
89 Y	2	1237700	2.36	1223523	101.2	65 - 125	
89 Y	3	7554058	0.84	7750993	97.5	65 - 125	
115 In	1	3985111	12.47	4390255	90.8	65 - 125	
115 In	2	1330240	0.77	1344115	99.0	65 - 125	
115 In	3	6604545	0.65	6947332	95.1	65 - 125	
118 (In)	1	18178	1.50	640	2840.2	65 - 125	
118 (In)	2	5664	0.48	213	2659.8	65 - 125	
118 (In)	3	23986	0.22	902	2658.3	65 - 125	
159 Tb	3	7094341	0.46	7525543	94.3	65 - 125	
165 Ho	3	6603883	1.74	7041058	93.8	65 - 125	
209 Bi	3	3024270	1.26	3329882	90.8	65 - 125	

Tune File# 1 d:\icpchem\1\7500\h2.u
 Tune File# 2 d:\icpchem\1\7500\he.u
 Tune File# 3 d:\icpchem\1\7500\no gas.u

ISTD Ref File : D:\ICPCHEM\1\DATA\06G31s00.B\028SMPL.D\028SMPL.D#

1 :Element Failures
 0 :ISTD Failures
 0 :Max. Number of Failures Allowed
 0 :Max. Number of ISTD Failures Allowed

Duplicate Sample QC Report

Data File: D:\ICPCHEM\1\DATA\06G31s00.B\038LFM2.D\038LFM2.D#
 Acquired: Jul 31 2006 09:25 pm
 Method: EPA.M
 Operator: GJW
 Sample Name: BM03401 MSD
 Misc Info: TOTAL WATER
 Vial Number: 2208
 Current Method: D:\ICPCHEM\1\METHODS\EPA.M
 Calibration File: D:\ICPCHEM\1\CALIB\EPA.C
 Last Cal. Update: Aug 01 2006 12:26 pm
 Sample Type: Dup2
 Dilution Factor: 10.00

Data Results:
 Analytes: Fail
 ISTD: Pass

Duplicate Ref File: D:\ICPCHEM\1\DATA\06G31s00.B\037LFM2.D\037LFM2.D#

QC Elements

Element	IS	Ref	Tune	Conc.	RSD(%)	Ref Conc	Differ(%)	High Limit	Flag
9	Be	6	3	210.00 ug/l	0.45	212.00	0.95	4	
23	Na	45	2	3308.00 ug/l	0.72	3379.00	2.12	4	
24	Mg	45	2	4024.00 ug/l	1.56	4133.00	2.67	4	
27	Al	45	3	206.50 ug/l	0.42	196.60	4.91	4	
39	K	45	2	2150.00 ug/l	1.01	2174.00	1.11	4	<3*IDL
40	Ca	45	1	11490.00 ug/l	13.91	9806.00	15.82	4	<3*IDL
51	V	89	2	230.60 ug/l	2.81	233.30	1.16	4	
52	Cr	89	2	224.80 ug/l	3.64	226.70	0.84	4	
55	Mn	89	2	233.00 ug/l	3.40	236.70	1.58	4	
56	Fe	89	1	2559.00 ug/l	13.94	2219.00	14.23	4	<3*IDL
59	Co	89	2	198.40 ug/l	2.48	201.80	1.70	4	
60	Ni	89	2	200.80 ug/l	2.84	203.90	1.53	4	
63	Cu	89	2	225.60 ug/l	2.81	228.10	1.10	4	
66	Zn	89	2	199.70 ug/l	2.48	200.50	0.40	4	
75	As	89	2	201.50 ug/l	2.19	203.80	1.13	4	
78	Se	115	1	237.40 ug/l	13.23	205.40	14.45	4	
95	Mo	89	3	230.30 ug/l	0.64	233.00	1.17	4	
106	(Cd)	115	3	207.20 ug/l	0.38	210.90	1.77	4	
107	Ag	115	3	1.85 ug/l	0.75	1.88	1.45	4	<3*IDL
	(Cd)	115	3	208.70 ug/l	0.92	212.90	1.99	4	
	Cd	115	3	227.30 ug/l	1.06	231.80	1.96	4	
121	Sb	165	3	204.20 ug/l	2.13	206.60	1.17	4	
137	Ba	159	3	245.40 ug/l	1.75	247.80	0.97	4	
205	Tl	165	3	191.40 ug/l	1.22	196.20	2.48	4	
206	(Pb)	209	3	267.60 ug/l	0.36	273.60	2.22	4	
207	(Pb)	209	3	265.70 ug/l	0.31	271.50	2.16	4	
208	Pb	209	3	199.90 ug/l	0.63	203.50	1.78	4	

ISTD Elements

Element	Tune	CPS Mean	RSD(%)	Ref Value	Rec(%)	QC Range(%)	Flag
6	Li	2135215	0.55	2187971	97.6	65 - 125	
7	(Li)	130855	0.91	117566	111.3	65 - 125	
45	Sc	1394662	13.44	1508375	92.5	65 - 125	
45	Sc	291503	0.94	284063	102.6	65 - 125	
45	Sc	5132345	0.55	5238429	98.0	65 - 125	
89	Y	3894524	12.81	4235101	92.0	65 - 125	
89	Y	1237700	2.36	1223523	101.2	65 - 125	
89	Y	7554058	0.84	7750993	97.5	65 - 125	
115	In	3985111	12.46	4390255	90.8	65 - 125	
115	In	1330240	0.77	1344115	99.0	65 - 125	
115	In	6604545	0.65	6947332	95.1	65 - 125	
118	(In)	18178	1.50	640	2840.2	65 - 125	
118	(In)	5664	0.48	213	2659.8	65 - 125	
118	(In)	23986	0.22	902	2658.3	65 - 125	
159	Tb	7094341	0.46	7525543	94.3	65 - 125	
165	Ho	6603883	1.74	7041058	93.8	65 - 125	
209	Bi	3024270	1.26	3329882	90.8	65 - 125	

Tune File# 1 d:\icpchem\1\7500\h2.u
 Tune File# 2 d:\icpchem\1\7500\he.u
 Tune File# 3 d:\icpchem\1\7500\no gas.u

ISTD Ref. File : D:\ICPCHEM\1\DATA\06G31s00.B\028SMPL.D\028SMPL.D#

4 :Element Failures 0 :Max. Number of Failures Allowed
 :ISTD Failures 0 :Max. Number of ISTD Failures Allowed

Laboratory Fortified Blank QC Report

ta File: D:\ICPCHEM\1\DATA\06G31s00.B\067_LFB.D\067_LFB.D#
 Date Acquired: Jul 31 2006 11:59 pm
 Acq. Method: EPA.M
 Operator: GJW
 Sample Name: M. STD. 07-27-06
 Misc Info: TOTAL WATER
 Vial Number: 2403
 Current Method: D:\ICPCHEM\1\METHODS\EPA.M
 Calibration File: D:\ICPCHEM\1\CALIB\EPA.C
 Last Cal. Update: Aug 01 2006 03:18 pm
 Sample Type: LFB
 Prep Dil. Factor: 10.00
 Autodil Factor: Undiluted
 Final Dil Factor: 10.00

Data Results:
 Analytes: Pass
 ISTD: Pass

Analyte Elements

Element	IS Ref	Tune	Conc. ppb	RSD(%)	Expected	Rec(%)	QC Range(%)	Flag
9 Be	6	3	212.70	5.78	200	106.4	80 - 120	
23 Na	45	2	1962.00	0.25	2000	98.1	80 - 120	
24 Mg	45	2	2008.00	0.56	2000	100.4	80 - 120	
27 Al	45	3	197.70	5.93	200	98.9	80 - 120	
39 K	45	2	1894.00	1.39	2000	94.7	80 - 120	
40 Ca	45	1	2047.00	2.92	2000	102.4	80 - 120	
51 V	89	2	223.60	0.93	200	111.8	80 - 120	
52 Cr	89	2	219.30	1.29	200	109.7	80 - 120	
55 Mn	89	2	225.30	1.25	200	112.7	80 - 120	
56 Fe	89	1	2029.00	1.60	2000	101.5	80 - 120	
59 Co	89	2	199.50	0.93	200	99.8	80 - 120	
60 Ni	89	2	204.70	0.98	200	102.4	80 - 120	
63 Cu	89	2	227.90	1.05	200	114.0	80 - 120	
65 Zn	89	2	188.80	0.77	200	94.4	80 - 120	
75 As	89	2	194.70	0.64	200	97.4	80 - 120	
78 Se	115	1	199.90	1.73	200	100.0	80 - 120	
95 Mo	89	3	219.20	5.55	200	109.6	80 - 120	
107 Ag	115	3	1.91	5.20	2	95.5	80 - 120	
111 Cd	115	3	233.90	5.32	200	117.0	80 - 120	
121 Sb	165	3	207.80	6.35	200	103.9	80 - 120	
137 Ba	159	3	230.40	6.58	200	115.2	80 - 120	
205 Tl	165	3	191.60	5.98	200	95.8	80 - 120	
208 Pb	209	3	202.80	6.56	200	101.4	80 - 120	

ISTD Elements

Element	Tune	CPS Mean	RSD(%)	Ref Value	Rec(%)	QC Range(%)	Flag
6 Li	3	2055917	5.88	2107855	97.5	65 - 125	
45 Sc	1	1522411	2.36	1482582	102.7	65 - 125	
45 Sc	2	281211	0.95	282124	99.7	65 - 125	
45 Sc	3	5081258	5.79	5173754	98.2	65 - 125	
89 Y	1	4372250	1.23	4235909	103.2	65 - 125	
89 Y	2	1191801	1.12	1195203	99.7	65 - 125	
89 Y	3	7455105	4.46	7589583	98.2	65 - 125	
115 In	1	4581073	1.74	4466716	102.6	65 - 125	
115 In	2	1294682	1.02	1308119	99.0	65 - 125	
115 In	3	6539556	5.46	6711286	97.4	65 - 125	
159 Tb	3	7025526	5.47	7238492	97.1	65 - 125	
165 Ho	3	6557558	5.65	6743901	97.2	65 - 125	
209 Bi	3	2977994	6.11	3091124	96.3	65 - 125	

Tune File# 1 d:\icpchem\1\7500\h2.u
 Tune File# 2 d:\icpchem\1\7500\he.u
 Tune File# 3 d:\icpchem\1\7500\no_gas.u

ISTD Ref File : D:\ICPCHEM\1\DATA\06G31s00.B\065SMPL.D\065SMPL.D#

0 :Element Failures
 0 :ISTD Failures

0 :Max. Number of Failures Allowed
 0 :Max. Number of ISTD Failures Allowed

Laboratory Fortified Matrix QC Report

ta File: D:\ICPCHEM\1\DATA\06G31s00.B\078LFM2.D\078LFM2.D#
 e Acquired: Aug 1 2006 12:57 am
 Acq. Method: EPA.M
 Operator: GJW
 Sample Name: BM03507 MS
 Misc Info: TOTAL WATER
 Vial Number: 2412
 Current Method: D:\ICPCHEM\1\METHODS\EPA.M
 Calibration File: D:\ICPCHEM\1\CALIB\EPA.C
 Last Cal. Update: Aug 01 2006 03:18 pm
 Sample Type: LFM2
 Prep Dil. Factor: 10.00
 Autodil Factor: Undiluted
 Final Dil Factor: 10.00

Data Results:

Analytes: Fail
 ISTD: Pass

Spike Ref. File: D:\ICPCHEM\1\DATA\06G31s00.B\077LFMR.D\077LFMR.D#

QC Elements

Element	IS Ref	Tune	Conc. ppb	Ref Conc	RSD(%)	Spk Amt	Rec(%)	QC Range(%)	QC Flag
9 Be	6	3	203.10	0.02	1.09	200.00	101.54	80 - 120	
23 Na	45	2	2810.00	1240.00	0.36	2000.00	78.50	80 - 120	Fail
24 Mg	45	2	2229.00	240.10	0.98	2000.00	99.44	80 - 120	
27 Al	45	3	205.70	23.73	1.31	200.00	90.99	80 - 120	
39 K	45	2	2229.00	392.20	0.60	2000.00	91.84	80 - 120	
40 Ca	45	1	3956.00	2153.00	1.21	2000.00	90.15	80 - 120	
51 V	89	2	219.50	0.23	1.08	200.00	109.64	80 - 120	
52 Cr	89	2	214.20	0.19	1.30	200.00	107.01	80 - 120	
55 Mn	89	2	221.10	3.07	1.89	200.00	109.02	80 - 120	
56 Fe	89	1	1976.00	32.39	1.19	2000.00	97.18	80 - 120	
59 Co	89	2	194.80	0.05	0.78	200.00	97.37	80 - 120	
60 Ni	89	2	200.30	0.86	1.00	200.00	99.72	80 - 120	
63 Cu	89	2	223.80	1.09	1.15	200.00	111.35	80 - 120	
66 Zn	89	2	188.90	4.90	1.25	200.00	92.00	80 - 120	
75 As	89	2	193.50	0.25	0.85	200.00	96.62	80 - 120	
78 Se	115	1	191.80	0.06	1.60	200.00	95.87	80 - 120	
95 Mo	89	3	208.70	0.85	2.03	200.00	103.92	80 - 120	
107 Ag	115	3	1.84	0.01	2.49	2.00	91.54	80 - 120	
111 Cd	115	3	220.20	0.03	2.72	200.00	110.08	80 - 120	
121 Sb	165	3	194.40	0.09	1.14	200.00	97.15	80 - 120	
137 Ba	159	3	221.30	4.10	0.84	200.00	108.60	80 - 120	
205 Tl	165	3	190.70	0.02	1.55	200.00	90.34	80 - 120	
208 Pb	209	3	190.70	0.26	1.64	200.00	95.22	80 - 120	

ISTD Elements

Element	Tune	Counts	RSD(%)	Ref. Counts	Rec(%)	QC Range(%)	QC Flag
6 Li	3	2107628	0.81	2107855	100.0	65 - 125	
7 (Li)	3	123213	1.20	112797	109.2	65 - 125	
45 Sc	1	1526482	1.66	1482582	103.0	65 - 125	
45 Sc	2	276823	1.13	282124	98.1	65 - 125	
45 Sc	3	5237222	1.26	5173754	101.2	65 - 125	
89 Y	1	4328532	1.54	4235909	102.2	65 - 125	
89 Y	2	1176485	1.14	1195203	98.4	65 - 125	
89 Y	3	7692079	1.48	7589583	101.4	65 - 125	
115 In	1	4547171	1.13	4466716	101.8	65 - 125	
115 In	2	1275376	1.44	1308119	97.5	65 - 125	
115 In	3	6749515	1.59	6711286	100.6	65 - 125	
118 (In)	1	1103	2.10	580	190.4	65 - 125	
118 (In)	2	350	9.66	153	228.3	65 - 125	
118 (In)	3	1505	5.82	717	209.9	65 - 125	
159 Tb	3	7225413	0.88	7238492	99.8	65 - 125	
165 Ho	3	6828742	1.04	6743901	101.3	65 - 125	
209 Bi	3	3055603	0.19	3091124	98.9	65 - 125	

Tune File# 1 d:\icpchem\1\7500\h2.u
 Tune File# 2 d:\icpchem\1\7500\he.u
 Tune File# 3 d:\icpchem\1\7500\no gas.u

ISTD Ref File : D:\ICPCHEM\1\DATA\06G31s00.B\065SMPL.D\065SMPL.D#

1 :Element Failures 0 :Max. Number of Failures Allowed
 0 :ISTD Failures 0 :Max. Number of ISTD Failures Allowed

Duplicate Sample QC Report

File: D:\ICPCHEM\1\DATA\06G31s00.B\079LFM2.D\079LFM2.D#
 Acquired: Aug 1 2006 01:02 am
 Method: EPA.M
 Operator: GJW
 Sample Name: BM03507 MSD
 Misc Info: TOTAL WATER
 Vial Number: 2413
 Current Method: D:\ICPCHEM\1\METHODS\EPA.M
 Calibration File: D:\ICPCHEM\1\CALIB\EPA.C
 Last Cal. Update: Aug 01 2006 03:18 pm
 Sample Type: Dup2
 Dilution Factor: 10.00

Data Results:
 Analytes: Fail
 ISTD: Pass

Duplicate Ref File: D:\ICPCHEM\1\DATA\06G31s00.B\078LFM2.D\078LFM2.D#

QC Elements

Element	IS Ref	Tune	Conc.	RSD(%)	Ref Conc	Differ(%)	High Limit	Flag
9 Be	6	3	203.10 ug/l	0.53	203.10	0.00	4	
23 Na	45	2	2817.00 ug/l	0.89	2810.00	0.25	4	<3*IDL
24 Mg	45	2	2240.00 ug/l	0.25	2229.00	0.49	4	<3*IDL
27 Al	45	3	208.50 ug/l	0.19	205.70	1.35	4	<3*IDL
39 K	45	2	2234.00 ug/l	0.75	2229.00	0.22	4	<3*IDL
40 Ca	45	1	3991.00 ug/l	0.47	3956.00	0.88	4	
51 V	89	2	221.90 ug/l	0.21	219.50	1.09	4	
52 Cr	89	2	216.30 ug/l	1.08	214.20	0.98	4	
55 Mn	89	2	222.80 ug/l	0.10	221.10	0.77	4	
56 Fe	89	1	2006.00 ug/l	1.58	1976.00	1.51	4	<3*IDL
59 Co	89	2	197.90 ug/l	0.41	194.80	1.58	4	
60 Ni	89	2	202.20 ug/l	0.48	200.30	0.94	4	
63 Cu	89	2	226.80 ug/l	0.70	223.80	1.33	4	
66 Zn	89	2	190.00 ug/l	0.38	188.90	0.58	4	
75 As	89	2	194.80 ug/l	0.57	193.50	0.67	4	
78 Se	115	1	197.40 ug/l	1.04	191.80	2.88	4	
95 Mo	89	3	213.70 ug/l	1.11	208.70	2.37	4	
106 (Cd)	115	3	204.60 ug/l	0.37	200.00	2.27	4	
107 Ag	115	3	1.86 ug/l	0.99	1.84	0.86	4	<3*IDL
108 (Cd)	115	3	207.90 ug/l	0.72	204.30	1.75	4	
112 Cd	115	3	225.30 ug/l	0.90	220.20	2.29	4	
121 Sb	165	3	197.00 ug/l	1.05	194.40	1.33	4	
137 Ba	159	3	225.60 ug/l	0.79	221.30	1.92	4	
205 Tl	165	3	182.10 ug/l	0.72	180.70	0.77	4	
206 (Pb)	209	3	261.80 ug/l	1.40	255.70	2.36	4	
207 (Pb)	209	3	259.10 ug/l	0.26	252.80	2.46	4	
208 Pb	209	3	195.10 ug/l	0.81	190.70	2.28	4	

ISTD Elements

Element	Tune	CPS Mean	RSD(%)	Ref Value	Rec(%)	QC Range(%)	Flag
6 Li	3	2137929	0.51	2107855	101.4	65 - 125	
7 (Li)	3	124824	0.43	112797	110.7	65 - 125	
45 Sc	1	1523756	0.36	1482582	102.8	65 - 125	
45 Sc	2	279477	0.20	282124	99.1	65 - 125	
45 Sc	3	5272647	0.20	5173754	101.9	65 - 125	
89 Y	1	4354950	0.68	4235909	102.8	65 - 125	
89 Y	2	1191215	0.43	1195203	99.7	65 - 125	
89 Y	3	7680871	0.99	7589583	101.2	65 - 125	
115 In	1	4559315	0.90	4466716	102.1	65 - 125	
115 In	2	1283112	0.41	1308119	98.1	65 - 125	
115 In	3	6773706	0.26	6711286	100.9	65 - 125	
118 (In)	1	994	0.53	580	171.5	65 - 125	
118 (In)	2	284	0.45	153	185.0	65 - 125	
118 (In)	3	1318	5.21	717	183.9	65 - 125	
159 Tb	3	7226391	0.82	7238492	99.8	65 - 125	
165 Ho	3	6851602	1.56	6743901	101.6	65 - 125	
209 Bi	3	3073955	1.37	3091124	99.4	65 - 125	

Tune File# 1 d:\icpchem\1\7500\h2.u
 Tune File# 2 d:\icpchem\1\7500\he.u
 Tune File# 3 d:\icpchem\1\7500\no gas.u

ISTD Ref. File : D:\ICPCHEM\1\DATA\06G31s00.B\065SMPL.D\065SMPL.D#

6 :Element Failures 0 :Max. Number of Failures Allowed
 0 :ISTD Failures 0 :Max. Number of ISTD Failures Allowed



2105 Pless Drive • Brighton, Michigan 48114 • Phone (810) 229-7575 • Fax (810) 229-8650

September 08, 2006

NTH Consultants, Ltd.
38955 Hills Tech Drive
Farmington Hills, MI 48333-3432

Subject: Ann Arbor WWTP

Dear Ms. Stearns :

Thank you for making Brighton Analytical, L.L.C. your laboratory of choice. Enclosed are the results for the samples submitted on 09/07/2006 for the above mentioned project. Duplicate copies can be supplied at your request for a fee of \$20.00 per copy.

Enclosed is the invoice for this project. If you have any questions concerning the invoice or the data, please don't hesitate to contact our office. Please reference Brighton Analytical, L.L.C. project ID 89125 when calling with any questions regarding this project.

Sincerely,
Brighton Analytical, L.L.C.

To: NTH Consultants, Ltd.
38955 Hills Tech Drive
Farmington Hills, MI 48333-3432

Sample Date: 09/07/2006
Submit Date: 09/07/2006
Report Date: 09/08/2006

BA Report Number: 89125
BA Sample ID: BM05724

Project Name: Ann Arbor WWTP
Project Number:
Sample ID: PW-2

Parameters	Results	Units	DL	Method Reference	Analyst	Analysis Date
Inorganic Analysis Available Cyanide	5	ug/L	2	OIA-1677	RM	09/08/2006

DL=Reported detection limit for analytical method requested. Some compounds require special analytical methods to achieve MDEQ designated target detection limits (TDL).

Released by:

Date: 9-8-06

To: NTH Consultants, Ltd.
38955 Hills Tech Drive
Farmington Hills, MI 48333-3432

Sample Date: 09/07/2006
Submit Date: 09/07/2006
Report Date: 09/08/2006

BA Report Number: **89125**
BA Sample ID: **BM05725**

Project Name: **Ann Arbor WWTP**
Project Number:
Sample ID: **PW-2 MS**

Parameters	Results	Units	DL	Method Reference	Analyst	Analysis Date
Inorganic Analysis Available Cyanide	109%	ug/L		OIA-1677	RM	09/08/2006

DL=Reported detection limit for analytical method requested. Some compounds require special analytical methods to achieve MDEQ designated target detection limits (TDL).

Released by 
Date: 9-8-06

Sample Date: 09/07/2006
Submit Date: 09/07/2006
Report Date: 09/08/2006


To: NTH Consultants, Ltd.
38955 Hills Tech Drive
Farmington Hills, MI 48333-3432

BA Report Number: **89125**
BA Sample ID: **BM05726**

Project Name: **Ann Arbor WWTP**
Project Number:
Sample ID: **PW-2 MSD**

Parameters	Results	Units	DL	Method Reference	Analyst	Analysis Date
Inorganic Analysis Available Cyanide	108%	ug/L		OIA-1677	RM	09/08/2006

DL=Reported detection limit for analytical method requested. Some compounds require special analytical methods to achieve MDEQ designated target detection limits (TDL).

Released by: 
Date: 9-8-06

To: NTH Consultants, Ltd.
38955 Hills Tech Drive
Farmington Hills, MI 48333-3432

Sample Date: 09/07/2006
Submit Date: 09/07/2006
Report Date: 09/08/2006

BA Report Number: **89125**
BA Sample ID: **BM05727**

Project Name: **Ann Arbor WWTP**
Project Number:
Sample ID: **Dup-1**

Parameters	Results	Units	DL	Method Reference	Analyst	Analysis Date
Inorganic Analysis Available Cyanide	6	ug/L	2	OIA-1677	RM	09/08/2006

DL=Reported detection limit for analytical method requested. Some compounds require special analytical methods to achieve MDEQ designated target detection limits (TDL).

Released by:



Date: 9-8-06

To: NTH Consultants, Ltd.
38955 Hills Tech Drive
Farmington Hills, MI 48333-3432

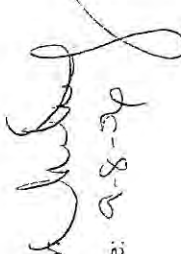
Sample Date: 09/07/2006
Submit Date: 09/07/2006
Report Date: 09/08/2006

BA Report Number: **89125**
BA Sample ID: **BM05728**

Project Name: **Ann Arbor WWTP**
Project Number:
Sample ID: **Field Blank**

Parameters	Results	Units	DL	Method Reference	Analyst	Analysis Date
Inorganic Analysis Available Cyanide	Not detected	ug/L	2	OIA-1677	RM	09/08/2006

DL=Reported detection limit for analytical method requested. Some compounds require special analytical methods to achieve MDEQ designated target detection limits (TDL).

Released by: 

Date: 9-8-06



Brighton Analytical, L.L.C.™

2105 Pless Drive
Brighton, MI 48114
Phone: 810-229-7575
Fax: 810-229-8650

COMPANY NAME: NTH (Malcolm Pirnie, Inc.)

PROJECT NAME: Ann Arbor WWTP

PROJECT NUMBER:

P. O. NUMBER:

REQUESTED TURNAROUND: (circle one)
Rush: 1-3 business days (verify with lab & specify date needed)
Expedited: 5 business days
Standard: 10 business days

IF RUSH,
approved by:

Sampling
Time Date

Brighton ID #

Sample Description

1) 05724 PW-2 9/17/06 1250
2) 05 PW-2 MS
3) 26 PW-2 MSD
4) 27 Dup-1
5) 27 Field Blank 1305

Container Type & Quantity

VOA'S (PRES) Y N
HDPE UNPRESERVED
HDPE HNO₃
HDPE H₂SO₄
HDPE NaOH
AMBER
GLASS H₂SO₄
GLASS, NO PRESERVATIVE
MEOH Preserved (Field or Lab Preserved)

X
↓
↓
↓
↓

Sample Matrix

FOR DISSOLVED METALS (L) LAB TO FILTER (F) FIELD FILTERED

Available Cyanide (OIA-1677)
L
↓
↓
↓
↓

Analysis Requested/Method

PAGE 1 OF

REPORT RESULTS TO:

NTH

Attn: MS. Beth Stearns (bstearns@nthaconsult.com)

PHONE:
FAX:

Sample received within holding time? yes no

For TCLP ONLY - Federal Limits Other

Samples intact: yes no (if no, see below)

Note samples if not intact:

Headspace/bubbles in VOA'S? yes no n/a

Sample containers and COC match? yes no

Comments:

Temperature of Samples °C: 00/100

Please fill out the Chain of Custody completely and review. Incorrect or incomplete information will result in a "hold" on all analyses.

Trans. #	RELINQUISHED BY:	RECEIVED BY:	DATE:	TIME:	Trans. #	RELINQUISHED BY:	RECEIVED BY:	DATE:	TIME:
1	Muller	W. T. J.	9/17/06	1351	3				
2					4				



BRIGHTON ANALYTICAL, L.L.C.

QUALITY ASSURANCE/QUALITY CONTROL

REPRESENTATIVE BATCH QUALITY CONTROL

Accuracy & Precision

Analyst: _____ RM

Parameter: _____ AVAILABLE CYAN

Analysis Date: _____ 9/8/2006

Method Reference: _____ 01A-1677

SPIKE - ACCURACY					
Laboratory ID	Spike Concentration	Background	% Recoveries	Acceptable Range (%)	Method Blank Concentration
BM05724	0.05	0.004624	109/108	80 - 120	<2
SPIKE - PRECISION					
Laboratory ID	Observed A	Observed B	RPD	Acceptable Range	
BM05724	0.058986	0.0585358	0.7	≤20%	
MISCELLANEOUS					
	Standard ID #				
Independent Secondary Reference Material:	0.05PPM STD	102%			
Method Standard (Laboratory Control Spike):					

COMMENTS: _____



2105 Pless Drive • Brighton, Michigan 48114 • Phone (810) 229-7575 • Fax (810) 229-8650

September 07, 2006

NTH Consultants, Ltd.
38955 Hills Tech Drive
Farmington Hills, MI 48333-3432

Subject:

Dear Ms. Stearns :

Thank you for making Brighton Analytical, L.L.C. your laboratory of choice. Enclosed are the results for the samples submitted on 08/30/2006 for the above mentioned project. Duplicate copies can be supplied at your request for a fee of \$20.00 per copy.

There is no invoice for this project. If you have any questions concerning the data, please don't hesitate to contact our office. Please reference Brighton Analytical, L.L.C. project ID 88793 when calling with any questions regarding this project.

Sincerely,
Brighton Analytical, L.L.C.

To: NTH Consultants, Ltd.
38955 Hills Tech Drive
Farmington Hills, MI 48333-3432

Sample Date: 08/30/2006
Submit Date: 08/30/2006
Report Date: 09/07/2006

BA Report Number: **88793**
BA Sample ID: **BM05314**

Project Name:
Project Number:
Sample ID: **PW-2**

Parameters	Results	Units	DL	Method Reference	Analyst	Analysis Date
Dissolved Metal Analysis						
Dissolved Iron	1.8	mg/L	0.02	EPA 200.8 rev5.5	GW	08/30/2006
Total Metal Analysis						
Total Antimony	Not detected	mg/L	0.002	EPA 200.8 rev5.5	GW	08/30/2006
Total Arsenic	Not detected	mg/L	0.001	EPA 200.8 rev5.5	GW	08/30/2006
Total Barium	0.18	mg/L	0.10	EPA 200.8 rev5.5	GW	08/30/2006
Total Beryllium	Not detected	mg/L	0.001	EPA 200.8 rev5.5	GW	08/30/2006
Total Boron	0.03	mg/L	0.02	EPA 200.7	KW	08/30/2006
Total Cadmium	0.0004	mg/L	0.0002	EPA 200.8 rev5.5	GW	08/30/2006
Total Chromium	Not detected	mg/L	0.005	EPA 200.8 rev5.5	GW	08/30/2006
Total Copper	Not detected	mg/L	0.004	EPA 200.8 rev5.5	GW	08/30/2006
Total Iron	2.6	mg/L	0.02	EPA 200.8 rev5.5	GW	08/30/2006
Total Lead	Not detected	mg/L	0.003	EPA 200.8 rev5.5	GW	08/30/2006
Total Mercury	Not detected	mg/L	0.0002	EPA 245.1	KW	08/30/2006
Total Nickel	Not detected	mg/L	0.02	EPA 200.8 rev5.5	GW	08/30/2006
Total Selenium	Not detected	mg/L	0.005	EPA 200.8 rev5.5	GW	08/30/2006
Total Silver	Not detected	mg/L	0.0002	EPA 200.8 rev5.5	GW	08/30/2006

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Parameters	Results	Units	DL	Method Reference	Analyst	Analysis Date
Total Thallium	Not detected	mg/L	0.002	EPA 200.8 rev5.5	GW	08/30/2006
Total Zinc	0.02	mg/L	0.01	EPA 200.8 rev5.5	GW	08/30/2006
Hardness by Calculation	350	mg/L	5.0	EPA 200.8 rev5.5	GW	08/30/2006
Mercury (digestion)	Digested			7470/7471	KW	08/30/2006
Metal Water Total (digest)	Digested			3015	PR	08/30/2006
Inorganic Analysis						
Ammonia	Not detected	mg/L	0.01	SM4500/350.1	RM	08/31/2006
Available Cyanide	6	ug/L	2	OIA-1677	RM	08/30/2006
Chloride	16	mg/L	1.0	SM4500/300	RM	08/30/2006
Phosphorus (total)	Not detected	mg/L	0.01	EPA 365.2	MB	08/31/2006
Total Dissolved Solids	410	mg/L	10	EPA 160.1	PR	08/31/2006
Total Suspended Solids	Not detected	mg/L	10	EPA 160.2	PR	08/31/2006
Organic Analysis						
Carbonaceous BOD	Not detected	mg/L	2.0	EPA 405.1	PR	08/31/2006
Phenol (4-AAP)	Not detected	mg/L	0.01	EPA 420.2	RM	08/31/2006
Microbiological Analysis						
Fecal Coliform	0	CFU/100	1	SM9221	WT	08/30/2006

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Semi-Volatile Analysis						
Acenaphthene	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Acenaphthylene	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Anthracene	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Benzo(a)anthracene	Not detected	ug/L	1	EPA 625	RG	08/31/2006
Benzo(a)pyrene	Not detected	ug/L	1	EPA 625	RG	08/31/2006
Benzo(b)fluoranthene	Not detected	ug/L	1	EPA 625	RG	08/31/2006
Benzo(ghi)perylene	Not detected	ug/L	1	EPA 625	RG	08/31/2006
Benzo(k)fluoranthene	Not detected	ug/L	1	EPA 625	RG	08/31/2006
Benzoic acid	Not detected	ug/L	50	EPA 625	RG	08/31/2006
Benzyl alcohol	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Bis(2-chloroethoxy)methane	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Bis(2-chloroethyl)ether	Not detected	ug/L	1	EPA 625	RG	08/31/2006
Bis(2-chloroisopropyl)ether	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Bis(2-ethylhexyl)phthalate	Not detected	ug/L	5	EPA 625	RG	08/31/2006
4-Bromophenyl phenyl ether	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Butyl benzyl phthalate	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Carbazole	Not detected	ug/L	10	EPA 625	RG	08/31/2006
4-Chloro-3-methylphenol	Not detected	ug/L	5	EPA 625	RG	08/31/2006

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Parameters	Results	Units	DL	Method Reference	Analyst	Analysis Date
4-Chloroaniline	Not detected	ug/L	10	EPA 625	RG	08/31/2006
2-Chloronaphthalene	Not detected	ug/L	5	EPA 625	RG	08/31/2006
2-Chlorophenol	Not detected	ug/L	5	EPA 625	RG	08/31/2006
4-Chlorophenyl phenyl ether	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Chrysene	Not detected	ug/L	1	EPA 625	RG	08/31/2006
Dibenzo(a,h)anthracene	Not detected	ug/L	2	EPA 625	RG	08/31/2006
Dibenzofuran	Not detected	ug/L	4	EPA 625	RG	08/31/2006
2,4-Dichlorophenol	Not detected	ug/L	5	EPA 625	RG	08/31/2006
2,6-Dichlorophenol	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Diethylphthalate	Not detected	ug/L	5	EPA 625	RG	08/31/2006
2,4-Dimethylphenol	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Dimethylphthalate	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Di-n-butylphthalate	Not detected	ug/L	5	EPA 625	RG	08/31/2006
4,6-Dinitro-2-methylphenol	Not detected	ug/L	20	EPA 625	RG	08/31/2006
2,4-Dinitrophenol	Not detected	ug/L	20	EPA 625	RG	08/31/2006
2,4-Dinitrotoluene	Not detected	ug/L	5	EPA 625	RG	08/31/2006
2,6-Dinitrotoluene	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Di-n-octylphthalate	Not detected	ug/L	5	EPA 625	RG	08/31/2006
1,2-Diphenylhydrazine	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Fluoranthene	Not detected	ug/L	1	EPA 625	RG	08/31/2006

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Parameters	Results	Units	DL	Method Reference	Analyst	Analysis Date
Fluorene	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Hexachlorobenzene	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Hexachlorobutadiene	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Hexachlorocyclopentadiene	Not detected	ug/L	2	EPA 625	RG	08/31/2006
Hexachloroethane	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Indeno(1,2,3)pyrene	Not detected	ug/L	2	EPA 625	RG	08/31/2006
Isophorone	Not detected	ug/L	5	EPA 625	RG	08/31/2006
2-Methylnaphthalene	Not detected	ug/L	5	EPA 625	RG	08/31/2006
2-Methylphenol (o-Cresol)	Not detected	ug/L	5	EPA 625	RG	08/31/2006
3&4-Methylphenol(m&p-Cresol)	Not detected	ug/L	5	EPA 625	RG	08/31/2006
2-Nitroaniline	Not detected	ug/L	20	EPA 625	RG	08/31/2006
3-Nitroaniline	Not detected	ug/L	20	EPA 625	RG	08/31/2006
4-Nitroaniline	Not detected	ug/L	20	EPA 625	RG	08/31/2006
Nitrobenzene	Not detected	ug/L	2	EPA 625	RG	08/31/2006
2-Nitrophenol	Not detected	ug/L	5	EPA 625	RG	08/31/2006
4-Nitrophenol	Not detected	ug/L	20	EPA 625	RG	08/31/2006
N-Nitrosodimethylamine	Not detected	ug/L	5	EPA 625	RG	08/31/2006
N-Nitrosodi-n-propylamine	Not detected	ug/L	5	EPA 625	RG	08/31/2006
N-Nitrosodiphenylamine	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Pentachlorophenol	Not detected	ug/L	20	EPA 625	RG	08/31/2006

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Phenanthrene	Not detected	ug/L	2	EPA 625	RG	08/31/2006
Phenol	Not detected	ug/L	5	EPA 625	RG	08/31/2006
Pyrene	Not detected	ug/L	5	EPA 625	RG	08/31/2006
1,2,4-Trichlorobenzene	Not detected	ug/L	5	EPA 625	RG	08/31/2006
2,4,5-Trichlorophenol	Not detected	ug/L	5	EPA 625	RG	08/31/2006
2,4,6-Trichlorophenol	Not detected	ug/L	4	EPA 625	RG	08/31/2006
BNA liquid (extraction)	Extracted			3510/3550	LS	08/31/2006
Semi-Volatile Surrogate Recovery						
d14-Terphenyl	100/173*	%	60-140	8270/625	RG	08/31/2006
d5-Nitrobenzene	82/81	%	60-140	8270/625	RG	08/31/2006
d6-Phenol	20*/20*	%	60-140	8270/625	RG	08/31/2006
2-Fluorobiphenyl	97/102	%	60-140	8270/625	RG	08/31/2006
2-Fluorophenol	33*/32*	%	60-140	8270/625	RG	08/31/2006
2,4,6-Tribromophenol	68/77	%	60-140	8270/625	RG	08/31/2006
Semi-Volatile Recheck						
Acenaphthene	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
Acenaphthylene	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
Anthracene	Not detected	ug/L	5	SW846 8270	RG	09/06/2006

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Parameters	Results	Units	DL	Method Reference	Analyst	Analysis Date
Benzo(a)anthracene	Not detected	ug/L	1	SW846 8270	RG	09/06/2006
Benzo(a)pyrene	Not detected	ug/L	1	SW846 8270	RG	09/06/2006
Benzo(b)fluoranthene	Not detected	ug/L	1	SW846 8270	RG	09/06/2006
Benzo(ghi)perylene	Not detected	ug/L	1	SW846 8270	RG	09/06/2006
Benzo(k)fluoranthene	Not detected	ug/L	1	SW846 8270	RG	09/06/2006
Benzoic acid	Not detected	ug/L	50	SW846 8270	RG	09/06/2006
Benzyl alcohol	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
Bis(2-chloroethoxy)methane	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
Bis(2-chloroethyl)ether	Not detected	ug/L	1	SW846 8270	RG	09/06/2006
Bis(2-chloroisopropyl)ether	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
Bis(2-ethylhexyl)phthalate	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
4-Bromophenyl phenyl ether	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
Butyl benzyl phthalate	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
Carbazole	Not detected	ug/L	10	SW846 8270	RG	09/06/2006
4-Chloro-3-methylphenol	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
4-Chloroaniline	Not detected	ug/L	10	SW846 8270	RG	09/06/2006
2-Chloronaphthalene	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
2-Chlorophenol	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
4-Chlorophenyl phenyl ether	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
Chrysene	Not detected	ug/L	1	SW846 8270	RG	09/06/2006

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Dibenzo(a,h)anthracene	Not detected	ug/L	2	SW846 8270	RG	09/06/2006
Dibenzofuran	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
2,4-Dichlorophenol	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
2,6-Dichlorophenol	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
Diethylphthalate	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
2,4-Dimethylphenol	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
Dimethylphthalate	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
Di-n-butylphthalate	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
4,6-Dinitro-2-methylphenol	Not detected	ug/L	20	SW846 8270	RG	09/06/2006
2,4-Dinitrophenol	Not detected	ug/L	20	SW846 8270	RG	09/06/2006
2,4-Dinitrotoluene	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
2,6-Dinitrotoluene	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
Di-n-octylphthalate	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
1,2-Diphenylhydrazine	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
Fluoranthene	Not detected	ug/L	1	SW846 8270	RG	09/06/2006
Fluorene	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
Hexachlorobenzene	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
Hexachlorobutadiene	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
Hexachlorocyclopentadiene	Not detected	ug/L	2	SW846 8270	RG	09/06/2006
Hexachloroethane	Not detected	ug/L	5	SW846 8270	RG	09/06/2006

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Indeno(1,2,3)pyrene	Not detected	ug/L	2	SW846 8270	RG	09/06/2006
Isophorone	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
2-Methylnaphthalene	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
2-Methylphenol (o-Cresol)	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
3&4-Methylphenol(m&p-Cresol)	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
2-Nitroaniline	Not detected	ug/L	20	SW846 8270	RG	09/06/2006
3-Nitroaniline	Not detected	ug/L	20	SW846 8270	RG	09/06/2006
4-Nitroaniline	Not detected	ug/L	20	SW846 8270	RG	09/06/2006
Nitrobenzene	Not detected	ug/L	2	SW846 8270	RG	09/06/2006
2-Nitrophenol	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
4-Nitrophenol	Not detected	ug/L	20	SW846 8270	RG	09/06/2006
N-Nitrosodimethylamine	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
N-Nitrosodi-n-propylamine	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
N-Nitrosodiphenylamine	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
Pentachlorophenol	Not detected	ug/L	20	SW846 8270	RG	09/06/2006
Phenanthrene	Not detected	ug/L	2	SW846 8270	RG	09/06/2006
Phenol	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
Pyrene	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
1,2,4-Trichlorobenzene	Not detected	ug/L	5	SW846 8270	RG	09/06/2006
2,4,5-Trichlorophenol	Not detected	ug/L	5	SW846 8270	RG	09/06/2006

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2,4,6-Trichlorophenol BNA (re-extract)	Not detected Extracted	ug/L	4	SW846 8270 3510/3550	RG LS	09/06/2006 09/06/2006
Volatile Analysis						
Acetone	Not detected	ug/L	20	SW846 8260B	JH	08/31/2006
Acrylonitrile	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Benzene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Bromobenzene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Bromochloromethane	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Bromodichloromethane	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Bromoform	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Bromomethane(Methyl Bromide)	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
2-Butanone (MEK)	Not detected	ug/L	5	SW846 8260B	JH	08/31/2006
Carbon disulfide	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Carbon tetrachloride	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Chlorobenzene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Chloroethane	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Chloroform	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Chloromethane(Methyl Chloride)	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
cis-1,2-Dichloroethene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006

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cis-1,3-Dichloropropene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
1,2-Dibromo-3-Chloropropane	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Dibromochloromethane	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
1,2-Dibromoethane	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Dibromomethane(Methylene Bromide)	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
1,2-Dichlorobenzene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
1,3-Dichlorobenzene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
1,4-Dichlorobenzene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Dichlorodifluoromethane	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
1,1-Dichloroethane	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
1,2-Dichloroethane	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
1,1-Dichloroethene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
1,2-Dichloropropane	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Diethyl ether	Not detected	ug/L	5	SW846 8260B	JH	08/31/2006
Diisopropyl Ether(DIPE)	Not detected	ug/L	5	SW846 8260B	JH	08/31/2006
Ethyl benzene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Ethyltertiarybutylether(ETBE)	Not detected	ug/L	5	SW846 8260B	JH	08/31/2006
Hexachloroethane	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
2-Hexanone(Methyl Butyl Ketone)	Not detected	ug/L	5	SW846 8260B	JH	08/31/2006
Isopropylbenzene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006

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Methyl iodide(Iodomethane)	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Methyl(tert)butyl ether(MTBE)	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
4-Methyl-2-pentanone(MIBK)	Not detected	ug/L	5	SW846 8260B	JH	08/31/2006
Methylene chloride	Not detected	ug/L	5	SW846 8260B	JH	08/31/2006
2-Methylnaphthalene	Not detected	ug/L	5	SW846 8260B	JH	08/31/2006
Naphthalene	Not detected	ug/L	5	SW846 8260B	JH	08/31/2006
n-Butylbenzene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
n-Propylbenzene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
p-Isopropyl Toluene(p-Cymene)	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
sec-Butylbenzene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Styrene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Tertiary Butyl Alcohol	Not detected	ug/L	50	SW846 8260B	JH	08/31/2006
tertiaryAmylmethyl ether(TAME)	Not detected	ug/L	5	SW846 8260B	JH	08/31/2006
tertiaryButylbenzene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
1,1,1,2-Tetrachloroethane	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
1,1,2,2-Tetrachloroethane	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Tetrachloroethene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Tetrahydrofuran	Not detected	ug/L	5	SW846 8260B	JH	08/31/2006
Toluene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
trans-1,2-Dichloroethene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006

To: NTH Consultants, Ltd.
38955 Hills Tech Drive
Farmington Hills, MI 48333-3432

Sample Date: 08/30/2006
Submit Date: 08/30/2006
Report Date: 09/07/2006

BA Report Number: 88793
BA Sample ID: BM05314

Project Name:
Project Number:
Sample ID: PW-2

Parameters	Results	Units	DL	Method Reference	Analyst	Analysis Date
trans-1,3-Dichloropropene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
trans-1,4-Dichloro-2-butene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
1,2,3-Trichlorobenzene	Not detected	ug/L	5	SW846 8260B	JH	08/31/2006
1,2,4-Trichlorobenzene	Not detected	ug/L	5	SW846 8260B	JH	08/31/2006
1,1,1-Trichloroethane	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
1,1,2-Trichloroethane	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Trichloroethene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Trichlorofluoromethane	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
1,2,3-Trichloropropane	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
1,2,3-Trimethylbenzene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
1,2,4-Trimethylbenzene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
1,3,5-Trimethylbenzene	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Vinyl chloride	Not detected	ug/L	1	SW846 8260B	JH	08/31/2006
Xylenes(total)	Not detected	ug/L	3	SW846 8260B	JH	08/31/2006
Volatile Surrogate Recovery						
4-Bromofluorobenzene	109	%	70-130	8260	JH	08/31/2006
d8-Toluene	104	%	70-130	8260	JH	08/31/2006
Dibromofluoromethane	101	%	70-130	8260	JH	08/31/2006



Brighton Analyti L.L.C.
 2105 Pless Drive
 Brighton, Michigan 48116
 Phone: (810) 229-7575 FAX: (810) 229-8650

TM

To: NTH Consultants, Ltd.
 38955 Hills Tech Drive
 Farmington Hills, MI 48333-3432

Sample Date: 08/30/2006
 Submit Date: 08/30/2006
 Report Date: 09/07/2006

BA Report Number: 88793
 BA Sample ID: BM05314

Project Name:
 Project Number:
 Sample ID: PW-2

Parameters	Results	Units	DL	Method Reference	Analyst	Analysis Date
------------	---------	-------	----	------------------	---------	---------------

DL=Reported detection limit for analytical method requested. Some compounds require special analytical methods to achieve MDEQ designated target detection limits (TDL).

Jeffrey
 9/7/06

Released by:
 Date:

* Semi-volatile surrogate recovery out of range due to sample matrix.



**ANALYTICAL SERVICES AUTHORIZATION
CHAIN-OF-CUSTODY RECORD**

TRAC NO. **80793**

PLEASE COMPLETE STEPS 1 THRU 3. TRACE PERSONNEL WILL COMPLETE SECTIONS SHADED BLUE.

Page **1** of **1**

Client Name: NTH
Contact Person: Beth Stearns
Mailing Address: 38955 Hillside Drive
City, State, Zip Code: Farmington Hills, MI 48331
Phone: 248-553-6300
Email Address: bstearns@nthconsultants.com
Client Job #: P.O. #:
Sampled By: Mike Brennan (Molecular Products, Inc.)

Report Results To: _____

STEP 1

Logged By: _____ **Checked By:** _____

Received on ice: Yes No

Cooler Temp (°C): _____ **ph Checked:** Yes No

Volatiles Preserved: HCl MeOH EtH Core No **Metals Pres:** Yes No

For Use by TRAC Personnel Only

Item #	Released By	Received By	Date	Time	Item #	Released By	Received By	Date	Time
1)	Muller	Muller	8/30/06	9:50am	2)				
3)					4)				

RUSH

on ice

STEP 2

Sample Identification / Request for Analytical Services

Trace No.	Date Taken	Time Taken	Metals Field Filtered	Volatiles Preserved	Client Sample ID	Matrix	Numbers of Containers	Remarks
81301060825	NO	Yes	PW-2	5314	W	9		Extra 100ml cup not used
(* Total Metals = Arsenic, Barium, Cadmium, Chromium, Copper, Lead, Nickel, Mercury, Silver, Selenium, Zinc, Antimony, Beryllium, Boron, Thallium, Iron)								

Possible Health Hazard

Executing this agreement, the client acknowledges acceptance of the terms of the agreement as listed on the reverse side.



BRIGHTON ANALYTICAL, L.L.C.

QUALITY ASSURANCE/QUALITY CONTROL

GC/MS

VOLATILE METHOD 8260

REPRESENTATIVE BATCH PRECISION AND ACCURACY QUALITY CONTROL SUMMARY

Analysis Date: 08/31/2006 Standard ID: #1189.2 Inst./Detec: VOL2-GC/MS
 Laboratory ID#: BM005314 Matrix: WATER Analyst: JH

SURROGATES	Matrix Spike - Precision *			Matrix Spike - Accuracy			**Method Blank ug/L
	Spike 1	Spike 2	Relative Percent Difference	Spk Conc	% Recovery	Range (%)	
d4-1,2-Dichloroethane	49.8	51.2	2.8	50ug/L	101	93 - 115	103%
D8-Toluene	47.3	47.9	1.3	50ug/L	95	93 - 126	95%
4-Bromofluorobenzene	47.3	48.8	3.1	50ug/L	96	81 - 101	103%
COMPOUNDS							
1,1-Dichloroethene	50.4	53.1	5.2	50ug/L	104%	83 - 126	<1
Trichloroethene	50.3	47.6	5.5	50ug/L	98%	93 - 127	<1
Benzene	56.6	52.4	7.7	50ug/L	109%	89 - 140	<1
Toluene	54.2	50.8	6.5	50ug/L	105%	94 - 134	<1
Chlorobenzene	47.6	46.1	3.2	50ug/L	94%	78 - 108	<1

* Matrix spike precision +/-20 Relative Percent Difference.

** (%) Range for Method Blank = 80 - 120%

(ug/L is equivalent to ppb)

Comments:

GC/MS

SEMI-VOLATILE METHOD 8270

REPRESENTATIVE EXTRACTION BATCH QUALITY CONTROL SUMMARY

Analysis Date: 08/31/2006

Extraction Date: 08/31/2006

Standard ID: #1224-1

Analyst: RG

Matrix: Water

SURROGATES	Method Standard % Recovery	Standard Concentration	Water Matrix Range	Method Blank µg/L
2-Fluorophenol	44	100ug/L	33-88	44
D5-Phenol	34	100ug/L	9-80	31
D5-Nitrobenzene	75	100ug/L	66-132	72
2-Fluorobiphenyl	92	100ug/L	51-164	85
2,4,6-Tribromophenol	83	100ug/L	62-135	68
D14-Terphenyl	85	100ug/L	56-195	100
COMPOUNDS				
Phenol	39	100ug/L	11-80	<5
2-Chlorophenol	84	100ug/L	68-103	<5
1,4-Dichlorobenzene	75	100ug/L	37-112	<5
N-nitrosodipropylamine	92	100ug/L	70-128	<5
1,2,4-Trichlorobenzene	86	100ug/L	43-137	<5
4-Chloro-3-Methyl Phenol	80	100ug/L	46-119	<5
Acenaphthene	95	100ug/L	62-160	<5
2,4 Dinitrotoluene	114	100ug/L	88-132	<5
4-Nitrophenol	42	100ug/L	4-76	<5
Pentachlorophenol	107	100ug/L	5-140	<20
Pyrene	119	100ug/L	79-178	<5

Comments: _____

GC/MS

SEMI-VOLATILE METHOD 8270

REPRESENTATIVE BATCH PRECISION AND ACCURACY QUALITY CONTROL SUMMARY

Analysis Date: 08/31/2006 Standard ID: #1224-1 Inst./Detec: HP5972/GC-MS
 Laboratory ID#: Method Stds. Matrix: WATER Analyst: RG

SURROGATES	Matrix Spike - Precision *			Matrix Spike - Accuracy			
	Spike 1	Spike 2	Relative Percent Difference	Spk Conc	% Recovery	Range (%)	Method Blank µg/L
2-Fluorophenol	46.0	44.0	4.4	100ug/L	45	34-88	44
D5-Phenol	35.0	34.0	2.9	100ug/L	35	9-80	31
D5-Nitrobenzene	76.0	75.0	1.3	100ug/L	76	66-133	72
2-Fluorobiphenyl	91.0	92.0	1.1	100ug/L	92	51-164	85
2,4,6-Tribromophenol	84.0	83.0	1.2	100ug/L	84	62-135	68
D14-Terphenyl	91.0	85.0	6.8	100ug/L	88	56-194	100
COMPOUNDS							
Phenol	39.0	39.0	0.0	100ug/L	39	11-80	<5
2-Chlorophenol	86.0	84.0	2.4	100ug/L	85	68-103	<5
1,4-Dichlorobenzene	78.0	75.0	3.9	100ug/L	77	37-112	<5
N-nitrosodipropylamine	96.0	92.0	4.3	100ug/L	94	70-128	<5
1,2,4-Trichlorobenzene	88.0	86.0	2.3	100ug/L	87	43-147	<5
4-Chloro-3-Methyl Phenol	79.0	80.0	1.3	100ug/L	80	46-119	<5
Acenaphthene	96.0	95.0	1.0	100ug/L	96	62-160	<5
2,4 Dinitrotoluene	108.0	114.0	5.4	100ug/L	111	88-132	<5
4 - Nitrophenol	40.0	42.0	4.9	100ug/L	41	5-76	<5
Pentachlorophenol	95.0	107.0	11.9	100ug/L	101	5-140	<20
Pyrene	131.0	119.0	9.6	100ug/L	125	79-178	<5

* Matrix Spike Precision +/-20 Relative Perce

Comments:

REPRESENTATIVE BATCH QUALITY CONTROL

Accuracy & Precision

Analyst: RM

Parameter: BOD

Analysis Date: 8/31/2006

Method Reference: EPA 405.1

SPIKE - ACCURACY					
Laboratory ID	Spike Concentration	Background	% Recoveries	Acceptable Range (%)	Method Blank Concentration
ERA P129	23.1	0.555	98	80 - 120	0.555
SPIKE - PRECISION					
Laboratory ID	Observed A	Observed B	RPD	Acceptable Range	
BM05176	282.5	295.75	4.6	≤ 20%	
MISCELLANEOUS					
		Standard ID #			
Independent Secondary Reference Material:					
Method Standard (Laboratory Control Spike):					

COMMENTS: _____

REPRESENTATIVE BATCH QUALITY CONTROL

Accuracy & Precision

Analyst: RM

Parameter: PHOSPHORUS

Analysis Date: 8/31/2006

Method Reference: EPA 365.2

SPIKE - ACCURACY					
Laboratory ID	Spike Concentration	Background	% Recoveries	Acceptable Range (%)	Method Blank Concentration
BM05314	0.5	<0.01	106/101	80 - 120	<0.01
SPIKE - PRECISION					
Laboratory ID	Observed A	Observed B	RPD	Acceptable Range	
BM05314	0.529	0.506	4.4	≤ 20%	
MISCELLANEOUS					
	Standard ID #				
Independent Secondary Reference Material:	ERA P125		103%		
Method Standard (Laboratory Control Spike):					

COMMENTS: _____

REPRESENTATIVE BATCH QUALITY CONTROL

Accuracy & Precision

Analyst: PR

Parameter: TSS

Analysis Date: 8/31/2006

Method Reference: 160.2

SPIKE - ACCURACY					
Laboratory ID	Spike Concentration	Background	% Recoveries	Acceptable Range (%)	Method Blank Concentration
ERA	48.3	ND	89	80 - 120	<10
SPIKE - PRECISION					
Laboratory ID	Observed A	Observed B	RPD	Acceptable Range	
BM05390	164	168	2.4	≤20%	
MISCELLANEOUS					
	Standard ID #				
Independent Secondary Reference Material:					

COMMENTS: _____

REPRESENTATIVE BATCH QUALITY CONTROL

Accuracy & Precision

Analyst: CW

Parameter: PHENOL

Analysis Date: 8/31/2006

Method Reference: EPA 420.2

SPIKE - ACCURACY				
Laboratory ID	Spike Concentration	Background	% Recoveries	Acceptable Range (%) Method Blank Concentration
BM05098	0.5	0.022	103/91	80 - 120 <0.01
SPIKE - PRECISION				
Laboratory ID	Observed A	Observed B	RPD	Acceptable Range
BM05098	0.535	0.478	11.3	≤20%
MISCELLANEOUS				
		Standard ID #		
Independent Secondary Reference Material:		ERA P129	104%	
Method Standard (Laboratory Control Spike):				

COMMENTS: _____

REPRESENTATIVE BATCH QUALITY CONTROL

Accuracy & Precision

Analyst: RM
 Analysis Date: 8/30/2006

Parameter: AVAILABLE CYAN
 Method Reference: 01A-1677

SPIKE - ACCURACY					
Laboratory ID	Spike Concentration	Background	% Recoveries	Acceptable Range (%)	Method Blank Concentration
BM04979	0.5	0.006917	111/101	80 - 120	<2
SPIKE - PRECISION					
Laboratory ID	Observed A	Observed B	RPD	Acceptable Range	
BM04979	0.062472	0.057239	8.7	≤ 20%	
MISCELLANEOUS					
		Standard ID #			
Independent Secondary Reference Material:		0.05PPM STD	95%		
Method Standard (Laboratory Control Spike):					

COMMENTS: *Low spike recovery due to sample matrix.

REPRESENTATIVE BATCH QUALITY CONTROL
Accuracy & Precision

Analyst: KW

Parameter: BORON

Analysis Date: 8/30/2006

Method Reference: 6010/200.7

SPIKE - ACCURACY					
Laboratory ID	Spike Concentration	Background	% Recoveries	Acceptable Range (%)	Method Blank Concentration
BM05314	4.0	0.0322	110/109	80 - 120	<0.02
SPIKE - PRECISION					
Laboratory ID	Observed A	Observed B	RPD	Acceptable Range	
BM05314	4.444	4.412	0.7	≤20%	
MISCELLANEOUS					
	Standard ID #				
Independent Secondary Reference Material:	SPEX 28A		106%		
Method Standard (Laboratory Control Spike):			107%		

COMMENTS: _____

METALS QC

- Page 1 – Results of Independent Check Standard
- Page 2 – Percent Recovery of Method Standard (M.STD)
- Page 3 – Percent Recovery of Sample Matrix Spike (MS)
- Page 4 – Percent Recovery of Sample Matrix Spike Duplicate (MSD)
- Page 5 – Relative Percent Difference (RPD) of MS/MSD

LCS QC Report

File : C:\HPCHEM\1\DATA\AUG3006.14A\009LCS_.D\009LCS_.D#
 Acquired : Aug 30 06 02:48 pm using AcqMethod DB200_8.M
 Operator : G.J.W.
 Sample Name: SPEX 1&3
 Misc Info :
 Vial Number: 2601
 CurrentMeth: C:\HPCHEM\1\METHODS\DB200_8.M
 BkgFile : -----
 Sample Type: LCS
 Dilution : 100.000000

Element	Concentration	Expected	QC Range	Flag
Be 9	9850.000 ug/l	10000.00	9000.00-11000.00	Pass
Na 23	198900.000 ug/l	200000.00	1.8000E+5-2.2000E+5	Pass
Mg 26	192300.000 ug/l	200000.00	1.8000E+5-2.2000E+5	Pass
Al 27	9660.000 ug/l	10000.00	9000.00-11000.00	Pass
K 39	193500.000 ug/l	200000.00	1.8000E+5-2.2000E+5	Pass
Ca 44	200700.000 ug/l	200000.00	1.8000E+5-2.2000E+5	Pass
V 51	9937.000 ug/l	10000.00	9000.00-11000.00	Pass
Cr 52	10130.000 ug/l	10000.00	9000.00-11000.00	Pass
Mn 55	9775.000 ug/l	10000.00	9000.00-11000.00	Pass
Fe 57	195800.000 ug/l	200000.00	1.8000E+5-2.2000E+5	Pass
Co 59	10110.000 ug/l	10000.00	9000.00-11000.00	Pass
Ni 60	9923.000 ug/l	10000.00	9000.00-11000.00	Pass
Cu 65	10020.000 ug/l	10000.00	9000.00-11000.00	Pass
Zn 66	9730.000 ug/l	10000.00	9000.00-11000.00	Pass
As 75	9609.000 ug/l	10000.00	9000.00-11000.00	Pass
Se 82	9974.000 ug/l	10000.00	9000.00-11000.00	Pass
Mo 98	9985.000 ug/l	10000.00	9000.00-11000.00	Pass
Ag 107	10210.000 ug/l	10000.00	9000.00-11000.00	Pass
Cd 111	9958.000 ug/l	10000.00	9000.00-11000.00	Pass
Sb 123	9339.000 ug/l	10000.00	9000.00-11000.00	Pass
Ba 137	10060.000 ug/l	10000.00	9000.00-11000.00	Pass
Tl 205	10530.000 ug/l	10000.00	9000.00-11000.00	Pass
Pb 208	9781.000 ug/l	10000.00	9000.00-11000.00	Pass

Internal Standard QC Report

ISTD m/z	Ref. Counts	Sample Counts	Flag
6	38917	41249	Pass
45	35272	40281	Pass
115	15655	18168	Pass
209	8104	9128	Pass

Internal Standards referenced to 013SMPL.D#

0 Element Failures. Maximum Number of Failures Allowed (5)
 0 ISTD Failures. Maximum Number of ISTD Failures Allowed (3)

Spiked Sample QC Report

File : C:\HPCHEM\1\DATA\AUG3006.14B\015SPK_.D\015SPK_.D#
 Acquired : Aug 30 06 03:20 pm using AcqMethod DB200_8.M
 Operator : G.J.W.
 Sample Name: M. STD. TOTAL H2O 08-30-06
 Misc Info : TOTAL WATER
 Vial Number: 2104
 CurrentMeth: C:\HPCHEM\1\METHODS\DB200_8.M
 BkgFile : -----
 Sample Type: SPIKE
 Dilution : 10.000000

Spike Reference Sample is C:\HPCHEM\1\DATA\AUG3006.14B\014SPKR.D\014SPKR.D#

Spike Recovery

Element	Conc.	Ref. Conc.	Conc. Added	%Rec.	QC Range	Flag
Be 9	1804.000 ug/l	-0.100	2000.0	90	80-120	Spk>Cal
Na 23	20800.000 ug/l	-64.600	20000	104	80-120	Pass
Mg 26	20050.000 ug/l	-3.344	20000	100	80-120	Pass
Al 27	1934.000 ug/l	4.448	2000.0	97	80-120	Spk>Cal
K 39	18830.000 ug/l	-772.700	20000	94	80-120	Pass
Ca 44	19670.000 ug/l	7.278	20000	98	80-120	Pass
V 51	2012.000 ug/l	0.005	2000.0	101	80-120	Spk>Cal
Cr 52	1998.000 ug/l	1.378	2000.0	100	80-120	Spk>Cal
Mn 55	1950.000 ug/l	0.533	2000.0	98	80-120	Spk>Cal
Fe 57	19880.000 ug/l	27.710	20000	99	80-120	Pass
Co 59	1998.000 ug/l	-0.087	2000.0	100	80-120	Spk>Cal
Ni 60	1985.000 ug/l	0.045	2000.0	99	80-120	Spk>Cal
Cu 65	1929.000 ug/l	1.548	2000.0	96	80-120	Spk>Cal
Zn 66	1902.000 ug/l	7.103	2000.0	95	80-120	Spk>Cal
As 75	1910.000 ug/l	0.284	2000.0	96	80-120	Spk>Cal
Se 82	1928.000 ug/l	5.263	2000.0	96	80-120	Spk>Cal
Mo 98	1893.000 ug/l	-0.161	2000.0	95	80-120	Spk>Cal
Ag 107	19.550 ug/l	-0.034	20.000	98	80-120	Pass
Cd 111	1942.000 ug/l	-0.390	2000.0	97	80-120	Spk>Cal
Sb 123	1925.000 ug/l	-0.182	2000.0	96	80-120	Spk>Cal
Ba 137	1937.000 ug/l	-0.191	2000.0	97	80-120	Spk>Cal
Tl 205	1943.000 ug/l	0.308	2000.0	97	80-120	Spk>Cal
Pb 208	1831.000 ug/l	0.032	2000.0	92	80-120	Spk>Cal

Internal Standard QC Report

ISTD m/z	Ref. Counts	Sample Counts	Flag
6	38917	44998	Pass
45	35272	40726	Pass
115	15655	17736	Pass
209	8104	9248	Pass

Internal Standards referenced to 013SMPL.D#

0 Element Failures. Maximum Number of Failures Allowed (5)
 0 ISTD Failures. Maximum Number of ISTD Failures Allowed (3)

Spiked Sample QC Report

File : C:\HPCHEM\1\DATA\Aug3006.14B\022SPK_.D\022SPK_.D#
 Acquired : Aug 30 06 03:55 pm using AcqMethod DB200_8.M
 Operator : G.J.W.
 Sample Name: BM05290 MS
 Misc Info : TOTAL WATER
 Vial Number: 2109
 CurrentMeth: C:\HPCHEM\1\METHODS\DB200_8.M
 BkgFile : -----
 Sample Type: SPIKE
 Dilution : 10.000000

Spike Reference Sample is C:\HPCHEM\1\DATA\Aug3006.14B\021SPKR.D\021SPKR.D#

Spike Recovery

Element	Conc.	Ref. Conc.	Conc. Added	%Rec.	QC Range	Flag
Be 9	1974.000 ug/l	-0.059	2000.0	99	80-120	Spk>Cal
Na 23	335300.000 ug/l	3.0590E+5	20000	147	80-120	High in SR
Mg 26	20330.000 ug/l	340.000	20000	100	80-120	Pass
Al 27	1950.000 ug/l	2.573	2000.0	98	80-120	Spk>Cal
K 39	20830.000 ug/l	716.700	20000	101	80-120	Pass
Ca 44	21040.000 ug/l	977.700	20000	100	80-120	Pass
V 51	2128.000 ug/l	-0.598	2000.0	106	80-120	Spk>Cal
Cr 52	2086.000 ug/l	-1.714	2000.0	104	80-120	Spk>Cal
Mn 55	2016.000 ug/l	0.644	2000.0	101	80-120	Spk>Cal
Fe 57	20890.000 ug/l	-301.100	20000	104	80-120	Pass
Co 59	2100.000 ug/l	-0.137	2000.0	105	80-120	Spk>Cal
Ni 60	2058.000 ug/l	0.608	2000.0	103	80-120	Spk>Cal
Cu 65	2017.000 ug/l	3.420	2000.0	101	80-120	Spk>Cal
Zn 66	1970.000 ug/l	30.120	2000.0	97	80-120	Spk>Cal
As 75	1999.000 ug/l	2.639	2000.0	100	80-120	Spk>Cal
Se 82	1985.000 ug/l	0.582	2000.0	99	80-120	Spk>Cal
Mo 98	2007.000 ug/l	3.239	2000.0	100	80-120	Spk>Cal
Ag 107	20.180 ug/l	-0.072	20.000	101	80-120	Pass
Cd 111	2011.000 ug/l	0.083	2000.0	101	80-120	Spk>Cal
Sb 123	2076.000 ug/l	-0.689	2000.0	104	80-120	Spk>Cal
Ba 137	2076.000 ug/l	1.840	2000.0	104	80-120	Spk>Cal
Tl 205	2039.000 ug/l	-0.991	2000.0	102	80-120	Spk>Cal
Pb 208	1925.000 ug/l	0.208	2000.0	96	80-120	Spk>Cal

Internal Standard QC Report

ISTD m/z	Ref. Counts	Sample Counts	Flag
6	38917	40419	Pass
45	35272	40146	Pass
115	15655	16762	Pass
209	8104	8880	Pass

Internal Standards referenced to 013SMPL.D#

0 Element Failures. Maximum Number of Failures Allowed (5)
 0 ISTD Failures. Maximum Number of ISTD Failures Allowed (3)

Spiked Sample QC Report

File : C:\HPCHEM\1\DATA\Aug3006.14B\023SPK_.D\023SPK_.D#
 Acquired : Aug 30 06 04:00 pm using AcqMethod DB200_8.M
 Operator : G.J.W.
 Sample Name: BM05290 MSD
 Misc Info : TOTAL WATER
 Vial Number: 2110
 CurrentMeth: C:\HPCHEM\1\METHODS\DB200_8.M
 BkgFile : -----
 Sample Type: SPIKE
 Dilution : 10.000000

Spike Reference Sample is C:\HPCHEM\1\DATA\Aug3006.14B\021SPKR.D\021SPKR.D#

Spike Recovery

Element	Conc.	Ref. Conc.	Conc. Added	%Rec.	QC Range	Flag
Be 9	1936.000 ug/l	-0.059	2000.0	97	80-120	Spk>Cal
Na 23	321100.000 ug/l	3.0590E+5	20000	76	80-120	High in SR
Mg 26	19510.000 ug/l	340.000	20000	96	80-120	Pass
Al 27	1851.000 ug/l	2.573	2000.0	93	80-120	Spk>Cal
K 39	21030.000 ug/l	716.700	20000	102	80-120	Pass
Ca 44	20480.000 ug/l	977.700	20000	98	80-120	Pass
V 51	2044.000 ug/l	-0.598	2000.0	102	80-120	Spk>Cal
Cr 52	2000.000 ug/l	-1.714	2000.0	100	80-120	Spk>Cal
Mn 55	1945.000 ug/l	0.644	2000.0	97	80-120	Spk>Cal
Fe 57	19590.000 ug/l	-301.100	20000	98	80-120	Pass
Co 59	1987.000 ug/l	-0.137	2000.0	99	80-120	Spk>Cal
Ni 60	1948.000 ug/l	0.608	2000.0	97	80-120	Spk>Cal
Cu 65	1926.000 ug/l	3.420	2000.0	96	80-120	Spk>Cal
Zn 66	1912.000 ug/l	30.120	2000.0	94	80-120	Spk>Cal
As 75	1901.000 ug/l	2.639	2000.0	95	80-120	Spk>Cal
Se 82	1901.000 ug/l	0.582	2000.0	95	80-120	Spk>Cal
Mo 98	1941.000 ug/l	3.239	2000.0	97	80-120	Spk>Cal
Ag 107	19.490 ug/l	-0.072	20.000	97	80-120	Pass
Cd 111	1953.000 ug/l	0.083	2000.0	98	80-120	Spk>Cal
Sb 123	2030.000 ug/l	-0.689	2000.0	102	80-120	Spk>Cal
Ba 137	2031.000 ug/l	1.840	2000.0	102	80-120	Spk>Cal
Tl 205	1998.000 ug/l	-0.991	2000.0	100	80-120	Spk>Cal
Pb 208	1888.000 ug/l	0.208	2000.0	94	80-120	Spk>Cal

Internal Standard QC Report

ISTD m/z	Ref. Counts	Sample Counts	Flag
6	38917	38860	Pass
45	35272	38530	Pass
115	15655	16551	Pass
209	8104	8800	Pass

Internal Standards referenced to 013SMPL.D#

0 Element Failures. Maximum Number of Failures Allowed (5)
 0 ISTD Failures. Maximum Number of ISTD Failures Allowed (3)

Duplicate QC Report

File : C:\HPCHEM\1\DATA\AUG3006.14B\023SPK_.D\023SPK_.D#
 Acquired : Aug 30 06 04:00 pm using AcqMethod DB200_8.M
 Operator : G.J.W.
 Sample Name: BM05290 MSD
 Misc Info : TOTAL WATER
 Vial Number: 2110
 CurrentMeth: C:\HPCHEM\1\METHODS\DB200_8.M
 BkgFile : -----
 Sample Type: SPIKE
 Dilution : 10.000000

Duplicate Reference Sample is C:\HPCHEM\1\DATA\AUG3006.14B\022SPK_.D\022SPK_

Element	Concentration	Reference	RPD or Delta	Allowed RPD or CRDL limit	Flag
Be 9	1936 ug/l	1974	1.94%	20%	Dup>Cal
Na 23	321100 ug/l	335300	4.33%	20%	Dup>Cal
Mg 26	19510 ug/l	20330	4.12%	20%	Pass
Al 27	1851 ug/l	1950	5.21%	20%	Dup>Cal
K 39	21030 ug/l	20830	0.96%	20%	Pass
Ca 44	20480 ug/l	21040	2.70%	20%	Pass
V 51	2044 ug/l	2128	4.03%	20%	Dup>Cal
Cr 52	2000 ug/l	2086	4.21%	20%	Dup>Cal
Mn 55	1945 ug/l	2016	3.59%	20%	Dup>Cal
Fe 57	19590 ug/l	20890	6.42%	20%	Pass
Co 59	1987 ug/l	2100	5.53%	20%	Dup>Cal
Ni 60	1948 ug/l	2058	5.49%	20%	Dup>Cal
Cu 65	1926 ug/l	2017	4.62%	20%	Dup>Cal
Zn 66	1912 ug/l	1970	2.99%	20%	Dup>Cal
As 75	1901 ug/l	1999	5.03%	20%	Dup>Cal
Se 82	1901 ug/l	1985	4.32%	20%	Dup>Cal
Mo 98	1941 ug/l	2007	3.34%	20%	Dup>Cal
Ag 107	19.49 ug/l	20.18	3.48%	20%	Pass
Cd 111	1953 ug/l	2011	2.93%	20%	Dup>Cal
Sb 123	2030 ug/l	2076	2.24%	20%	Dup>Cal
Ba 137	2031 ug/l	2076	2.19%	20%	Dup>Cal
Tl 205	1998 ug/l	2039	2.03%	20%	Dup>Cal
Pb 208	1888 ug/l	1925	1.94%	20%	Dup>Cal

Internal Standard QC Report

ISTD m/z	Ref. Counts	Sample Counts	Flag
6	38917	38860	Pass
45	35272	38530	Pass
115	15655	16551	Pass
209	8104	8800	Pass

Internal Standards referenced to 013SMPL.D#

0 Element Failures. Maximum Number of Failures Allowed (5)
 0 ISTD Failures. Maximum Number of ISTD Failures Allowed (3)

LCS QC Report

File : C:\HPCHEM\1\DATA\AUG3006.14A\009LCS_.D\009LCS_.D#
 Acquired : Aug 30 06 02:48 pm using AcqMethod DB200_8.M
 Operator : G.J.W.
 Sample Name: SPEX 1&3
 Misc Info :
 Vial Number: 2601
 CurrentMeth: C:\HPCHEM\1\METHODS\DB200_8.M
 BkgFile : -----
 Sample Type: LCS
 Dilution : 100.000000

Element	Concentration	Expected	QC Range	Flag
Be 9	9850.000 ug/l	10000.00	9000.00-11000.00	Pass
Na 23	198900.000 ug/l	200000.00	1.8000E+5-2.2000E+5	Pass
Mg 26	192300.000 ug/l	200000.00	1.8000E+5-2.2000E+5	Pass
Al 27	9660.000 ug/l	10000.00	9000.00-11000.00	Pass
K 39	193500.000 ug/l	200000.00	1.8000E+5-2.2000E+5	Pass
Ca 44	200700.000 ug/l	200000.00	1.8000E+5-2.2000E+5	Pass
V 51	9937.000 ug/l	10000.00	9000.00-11000.00	Pass
Cr 52	10130.000 ug/l	10000.00	9000.00-11000.00	Pass
Mn 55	9775.000 ug/l	10000.00	9000.00-11000.00	Pass
Fe 57	195800.000 ug/l	200000.00	1.8000E+5-2.2000E+5	Pass
Co 59	10110.000 ug/l	10000.00	9000.00-11000.00	Pass
Ni 60	9923.000 ug/l	10000.00	9000.00-11000.00	Pass
Cu 65	10020.000 ug/l	10000.00	9000.00-11000.00	Pass
Zn 66	9730.000 ug/l	10000.00	9000.00-11000.00	Pass
As 75	9609.000 ug/l	10000.00	9000.00-11000.00	Pass
Se 82	9974.000 ug/l	10000.00	9000.00-11000.00	Pass
Mo 98	9985.000 ug/l	10000.00	9000.00-11000.00	Pass
Ag 107	10210.000 ug/l	10000.00	9000.00-11000.00	Pass
Cd 111	9958.000 ug/l	10000.00	9000.00-11000.00	Pass
Sb 123	9339.000 ug/l	10000.00	9000.00-11000.00	Pass
Ba 137	10060.000 ug/l	10000.00	9000.00-11000.00	Pass
Tl 205	10530.000 ug/l	10000.00	9000.00-11000.00	Pass
Pb 208	9781.000 ug/l	10000.00	9000.00-11000.00	Pass

Internal Standard QC Report

ISTD m/z	Ref. Counts	Sample Counts	Flag
6	38917	41249	Pass
45	35272	40281	Pass
115	15655	18168	Pass
209	8104	9128	Pass

Internal Standards referenced to 013SMPL.D#

0 Element Failures. Maximum Number of Failures Allowed (5)
 0 ISTD Failures. Maximum Number of ISTD Failures Allowed (3)

Spiked Sample QC Report

File : C:\HPCHEM\1\DATA\AUG3006.14B\050SPK_.D\050SPK_.D#
 Acquired : Aug 30 06 06:19 pm using AcqMethod DB200_8.M
 Operator : G.J.W.
 Sample Name: M. STD. DISSOLVED 08-30-06
 Misc Info : DISSOLVED WATER
 Vial Number: 2409
 CurrentMeth: C:\HPCHEM\1\METHODS\DB200_8.M
 BkgFile : -----
 Sample Type: SPIKE
 Dilution : 10.000000

Spike Reference Sample is C:\HPCHEM\1\DATA\AUG3006.14B\046SPKR.D\046SPKR.D#

Spike Recovery

Element	Conc.	Ref. Conc.	Conc. Added	%Rec.	QC Range	Flag
Be 9	1946.000 ug/l	-0.091	2000.0	97	80-120	Spk>Cal
Na 23	19230.000 ug/l	-76.970	20000	96	80-120	Pass
Mg 26	18430.000 ug/l	-18.100	20000	92	80-120	Pass
Al 27	1850.000 ug/l	-25.890	2000.0	92	80-120	Spk>Cal
K 39	20960.000 ug/l	-242.000	20000	105	80-120	Pass
Ca 44	20100.000 ug/l	140.800	20000	100	80-120	Pass
V 51	1885.000 ug/l	0.133	2000.0	94	80-120	Spk>Cal
Cr 52	1904.000 ug/l	0.255	2000.0	95	80-120	Spk>Cal
Mn 55	1877.000 ug/l	0.815	2000.0	94	80-120	Spk>Cal
Fe 57	19330.000 ug/l	-8.758	20000	97	80-120	Pass
Co 59	1969.000 ug/l	-0.055	2000.0	98	80-120	Spk>Cal
Ni 60	1928.000 ug/l	0.127	2000.0	96	80-120	Spk>Cal
Cu 65	1851.000 ug/l	0.141	2000.0	93	80-120	Spk>Cal
Zn 66	1981.000 ug/l	1.744	2000.0	99	80-120	Spk>Cal
As 75	1925.000 ug/l	0.195	2000.0	96	80-120	Spk>Cal
Se 82	2033.000 ug/l	0.892	2000.0	102	80-120	Spk>Cal
Mo 98	1975.000 ug/l	-0.302	2000.0	99	80-120	Spk>Cal
Ag 107	19.780 ug/l	0.006	20.000	99	80-120	Pass
Cd 111	2077.000 ug/l	-0.116	2000.0	104	80-120	Spk>Cal
Sb 123	2100.000 ug/l	-0.140	2000.0	105	80-120	Spk>Cal
Ba 137	2096.000 ug/l	-0.222	2000.0	105	80-120	Spk>Cal
Tl 205	2494.000 ug/l	-0.085	2000.0	125	80-120	Spk>Cal
Pb 208	2359.000 ug/l	-0.063	2000.0	118	80-120	Spk>Cal

Internal Standard QC Report

ISTD m/z	Ref. Counts	Sample Counts	Flag
6	31747	37449	Pass
45	32262	36910	Pass
115	14774	16811	Pass
209	7583	7654	Pass

Internal Standards referenced to 042SMPL.D#

0 Element Failures. Maximum Number of Failures Allowed (5)
 0 ISTD Failures. Maximum Number of ISTD Failures Allowed (3)

Duplicate QC Report

File : C:\HPCHEM\1\DATA\AUG3006.14B\049SPK_.D\049SPK_.D#
 Acquired : Aug 30 06 06:14 pm using AcqMethod DB200_8.M
 Operator : G.J.W.
 Sample Name: BM05314 MSD
 Misc Info : DISSOLVED WATER
 Vial Number: 2408
 CurrentMeth: C:\HPCHEM\1\METHODS\DB200_8.M
 BkgFile : -----
 Sample Type: SPIKE
 Dilution : 10.000000

Duplicate Reference Sample is C:\HPCHEM\1\DATA\AUG3006.14B\048SPK_.D\048SPK_

Element	Concentration	Reference	RPD or Delta	Allowed RPD or CRDL limit	Flag
Be 9	2034 ug/l	1925	5.51%	20%	Dup>Cal
Na 23	28540 ug/l	28420	0.42%	20%	Pass
Mg 26	40160 ug/l	40250	0.22%	20%	Pass
Al 27	1837 ug/l	1793	2.42%	20%	Dup>Cal
K 39	22340 ug/l	21730	2.77%	20%	Pass
Ca 44	114100 ug/l	112000	1.86%	20%	Dup>Cal
V 51	1997 ug/l	1917	4.09%	20%	Dup>Cal
Cr 52	1993 ug/l	1933	3.06%	20%	Dup>Cal
Mn 55	1990 ug/l	1937	2.70%	20%	Dup>Cal
Fe 57	21820 ug/l	21580	1.11%	20%	Pass
Co 59	1993 ug/l	1953	2.03%	20%	Dup>Cal
Ni 60	1960 ug/l	1909	2.64%	20%	Dup>Cal
Cu 65	1913 ug/l	1877	1.90%	20%	Dup>Cal
Zn 66	1873 ug/l	1843	1.62%	20%	Dup>Cal
As 75	1923 ug/l	1871	2.74%	20%	Dup>Cal
Se 82	1896 ug/l	1837	3.16%	20%	Dup>Cal
Mo 98	2035 ug/l	2001	1.69%	20%	Dup>Cal
Ag 107	19.58 ug/l	19.38	1.03%	20%	Pass
Cd 111	2020 ug/l	1955	3.27%	20%	Dup>Cal
Sb 123	2085 ug/l	2038	2.28%	20%	Dup>Cal
Ba 137	2273 ug/l	2217	2.49%	20%	Dup>Cal
Tl 205	2040 ug/l	1941	4.97%	20%	Dup>Cal
Pb 208	1919 ug/l	1841	4.15%	20%	Dup>Cal

Internal Standard QC Report

ISTD m/z	Ref. Counts	Sample Counts	Flag
6	31747	36597	Pass
45	32262	37714	Pass
115	14774	16449	Pass
209	7583	8888	Pass

Internal Standards referenced to 042SMPL.D#

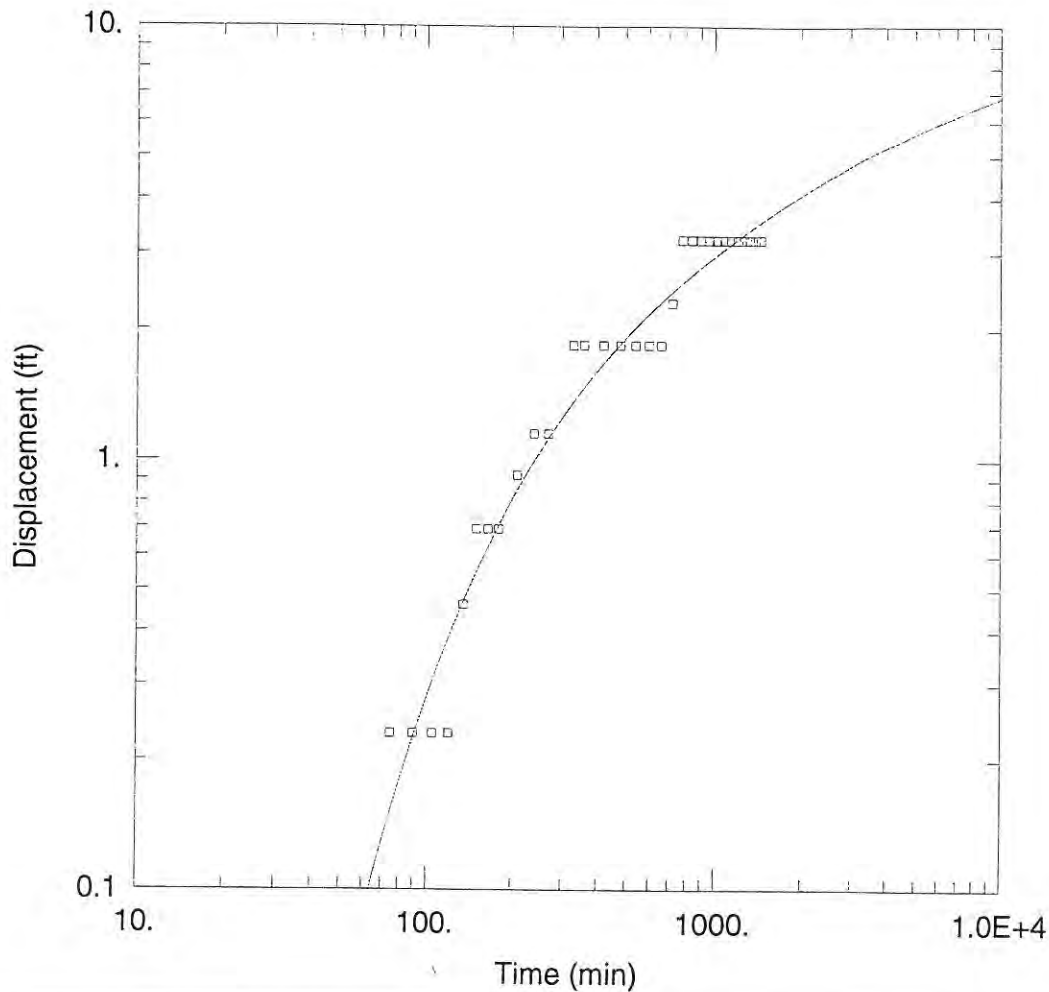
0 Element Failures. Maximum Number of Failures Allowed (5)
 0 ISTD Failures. Maximum Number of ISTD Failures Allowed (3)



APPENDIX E

PUMPING TEST ANALYSIS PLOTS & GRAPHS:

- **AQTESOLV® ANALYSIS PLOTS**
- **DISTANCE VS. DRAWDOWN GRAPH**
- **ZONE OF INFLUENCE VS. TIME GRAPH**



AAWWTP PUMP TEST

Data Set: S:\Waste\HOHNER\AAWWTP\Pump Test Data & Analysis\PT2_107.aqt
 Date: 11/22/06 Time: 13:15:48

PROJECT INFORMATION

Company: NTH
 Client: Malcolm-Pirnie
 Project: 15-050510-06
 Location: Ann Arbor
 Test Well: PW-2
 Test Date: 9-7-06

WELL DATA

Pumping Wells

Observation Wells

Well Name	X (ft)	Y (ft)
PW-2	0	0

Well Name	X (ft)	Y (ft)
□ PZ-107	155	0

SOLUTION

Aquifer Model: Leaky

Solution Method: Hantush-Jacob

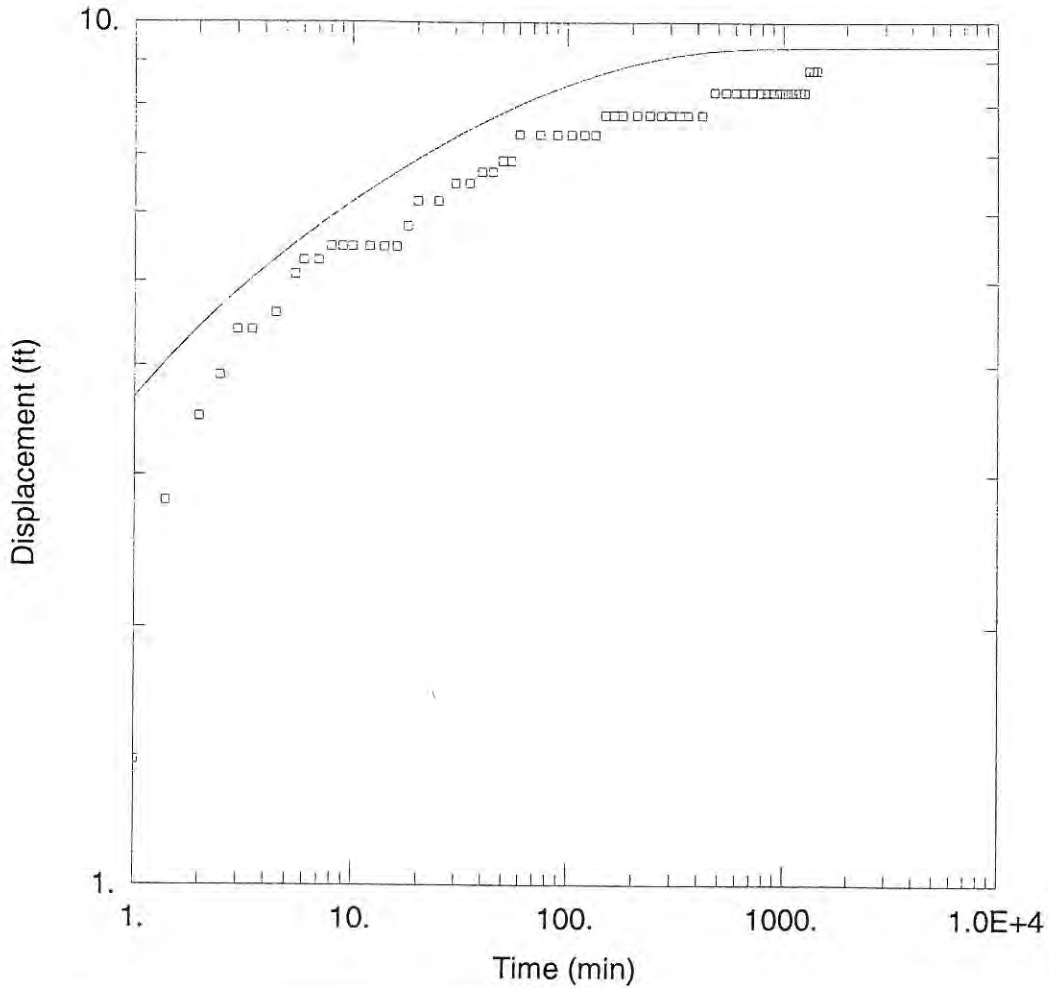
T = 1.337E+4 gal/day/ft

S = 0.02504

r/B = 0.05

Kz/Kr = 1.

b = 21. ft



AAWWTP PUMP TEST

Data Set: S:\Waste\HOHNER\AAWWTP\Pump Test Data & Analysis\PT2_202.aqt
 Date: 11/22/06 Time: 13:16:29

PROJECT INFORMATION

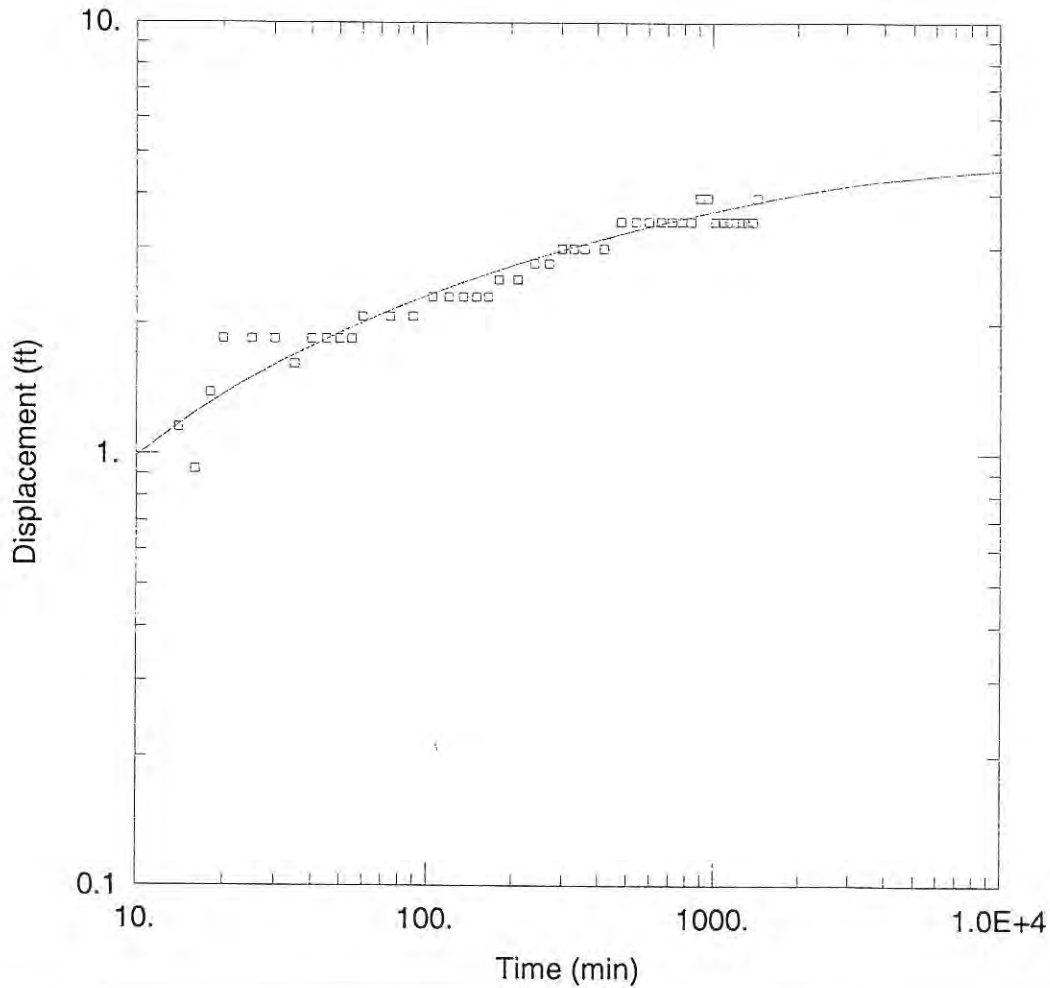
Company: NTH
 Client: Malcolm-Pirnie
 Project: 15-050510-06
 Location: Ann Arbor
 Test Well: PW-2
 Test Date: 9-7-06

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2	0	0	□ PZ-202	10	0

SOLUTION

Aquifer Model: <u>Leaky</u>	Solution Method: <u>Hantush-Jacob</u>
T = <u>2.153E+4 gal/day/ft</u>	S = <u>0.001711</u>
r/B = <u>0.01712</u>	Kz/Kr = <u>1.</u>
b = <u>21. ft</u>	



AAWWTP PUMP TEST

Data Set: S:\Waste\HOHNER\AAWWTP\Pump Test Data & Analysis\PT2_203.aqt
 Date: 11/22/06 Time: 13:17:34

PROJECT INFORMATION

Company: NTH
 Client: Malcolm-Pirnie
 Project: 15-050510-06
 Location: Ann Arbor
 Test Well: PW-2
 Test Date: 9-7-06

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2	0	0	□ PZ-203	240	0

SOLUTION

Aquifer Model: Leaky

Solution Method: Hantush-Jacob

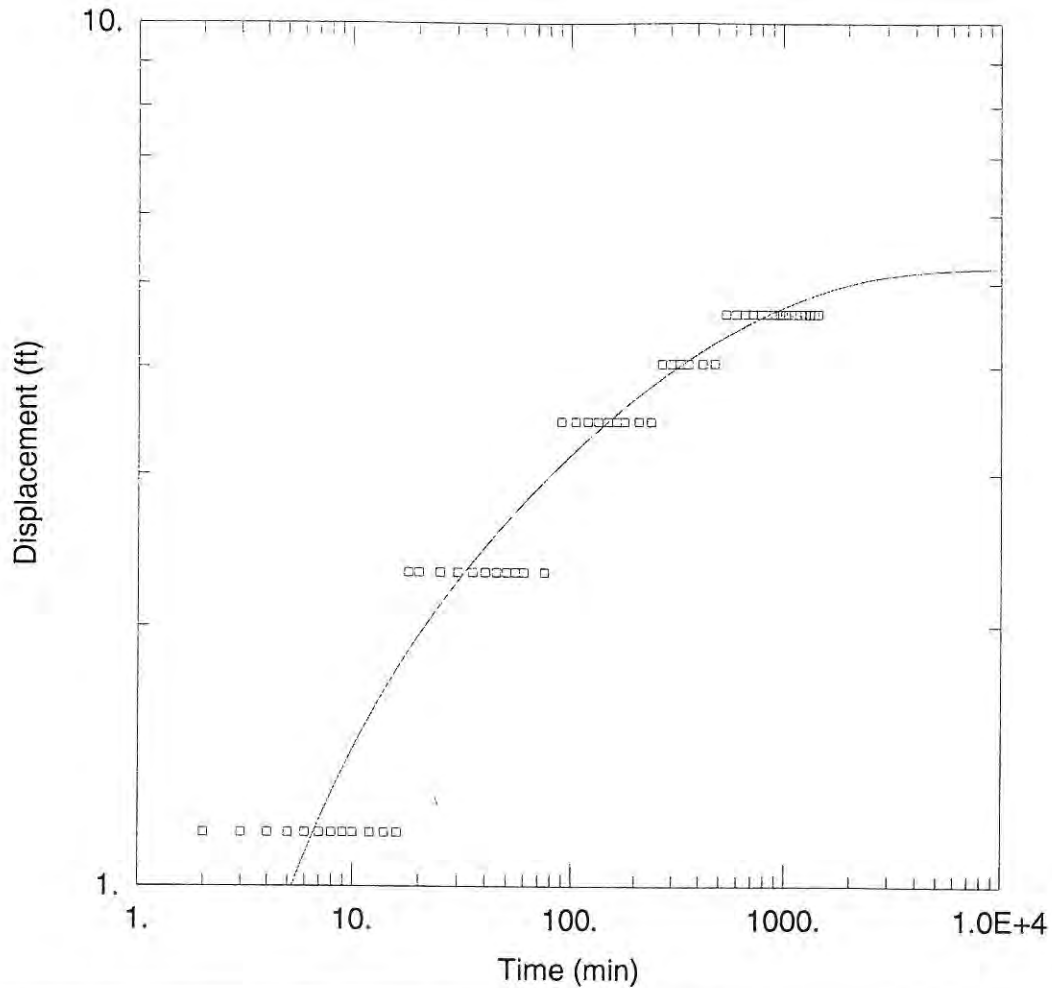
T = 4.006E+4 gal/day/ft

S = 0.0003284

r/B = 0.02557

Kz/Kr = 1.

b = 21. ft



AAWWTP PUMP TEST

Data Set: S:\Waste\HOHNER\AAWWTP\Pump Test Data & Analysis\PT2_302.aqt
 Date: 11/22/06 Time: 13:18:04

PROJECT INFORMATION

Company: NTH
 Client: Malcolm-Pirnie
 Project: 15-050510-06
 Location: Ann Arbor
 Test Well: PW-2
 Test Date: 9-7-06

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2	0	0	□ PZ-302	110	0

SOLUTION

Aquifer Model: Leaky

Solution Method: Hantush-Jacob

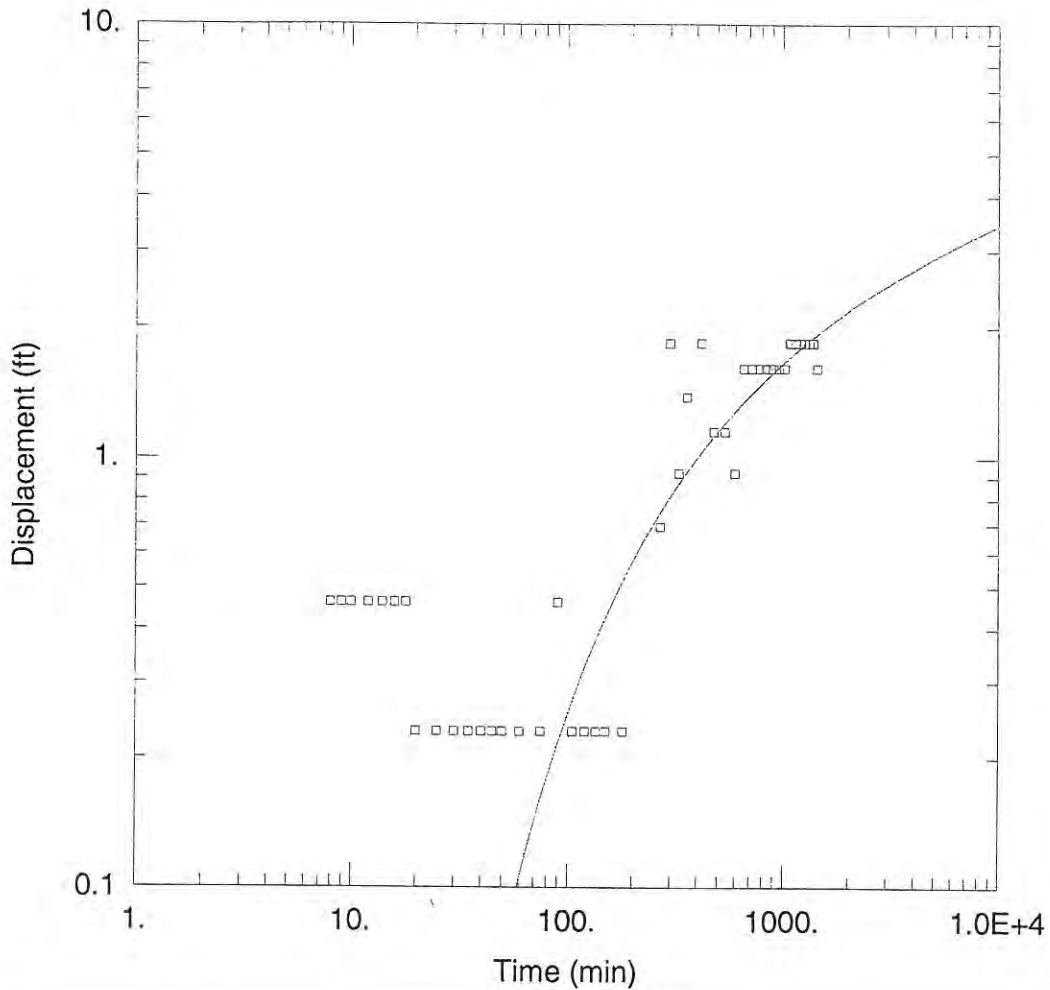
T = 3.111E+4 gal/day/ft

S = 0.0009397

r/B = 0.04138

Kz/Kr = 1.

b = 21. ft



AAWWTP PUMP TEST

Data Set: S:\Waste\HOHNER\AAWWTP\Pump Test Data & Analysis\PT2_307.aqt
 Date: 11/22/06 Time: 13:18:31

PROJECT INFORMATION

Company: NTH
 Client: Malcolm-Pirnie
 Project: 15-050510-06
 Location: Ann Arbor
 Test Well: PW-2
 Test Date: 9-7-06

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2	0	0	PZ-307	390	0

SOLUTION

Aquifer Model: Leaky

Solution Method: Hantush-Jacob

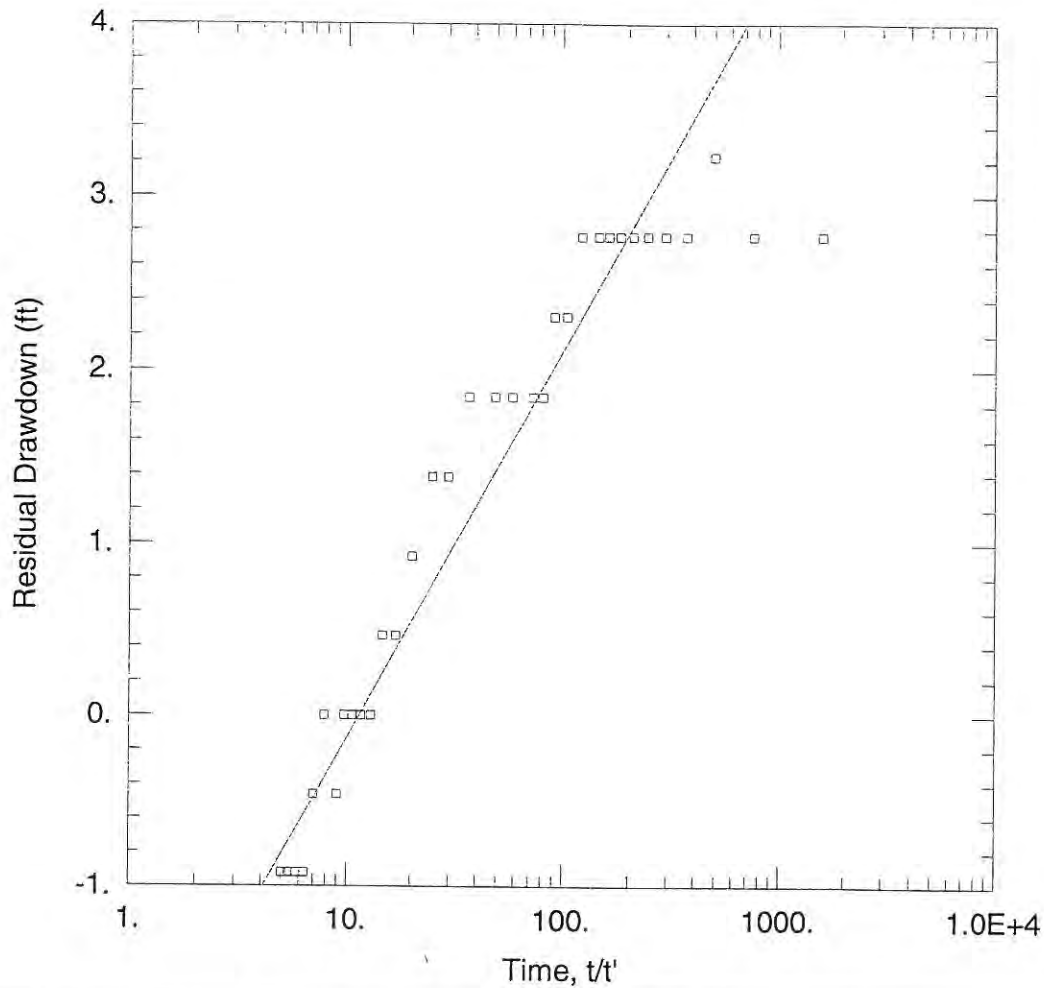
T = 2.985E+4 gal/day/ft

S = 0.005842

r/B = 0.05

Kz/Kr = 1.

b = 21. ft



AAWWTP PUMP TEST - RECOVERY PHASE

Data Set: S:\Waste\HOHNER\AAWWTP\Pump Test Data & Analysis\PT2_REC_107.aqt
 Date: 11/22/06 Time: 13:19:10

PROJECT INFORMATION

Company: NTH
 Client: Malcolm-Pirnie
 Project: 15-050510-06
 Location: Ann Arbor
 Test Well: PW-2
 Test Date: 9-7-06

AQUIFER DATA

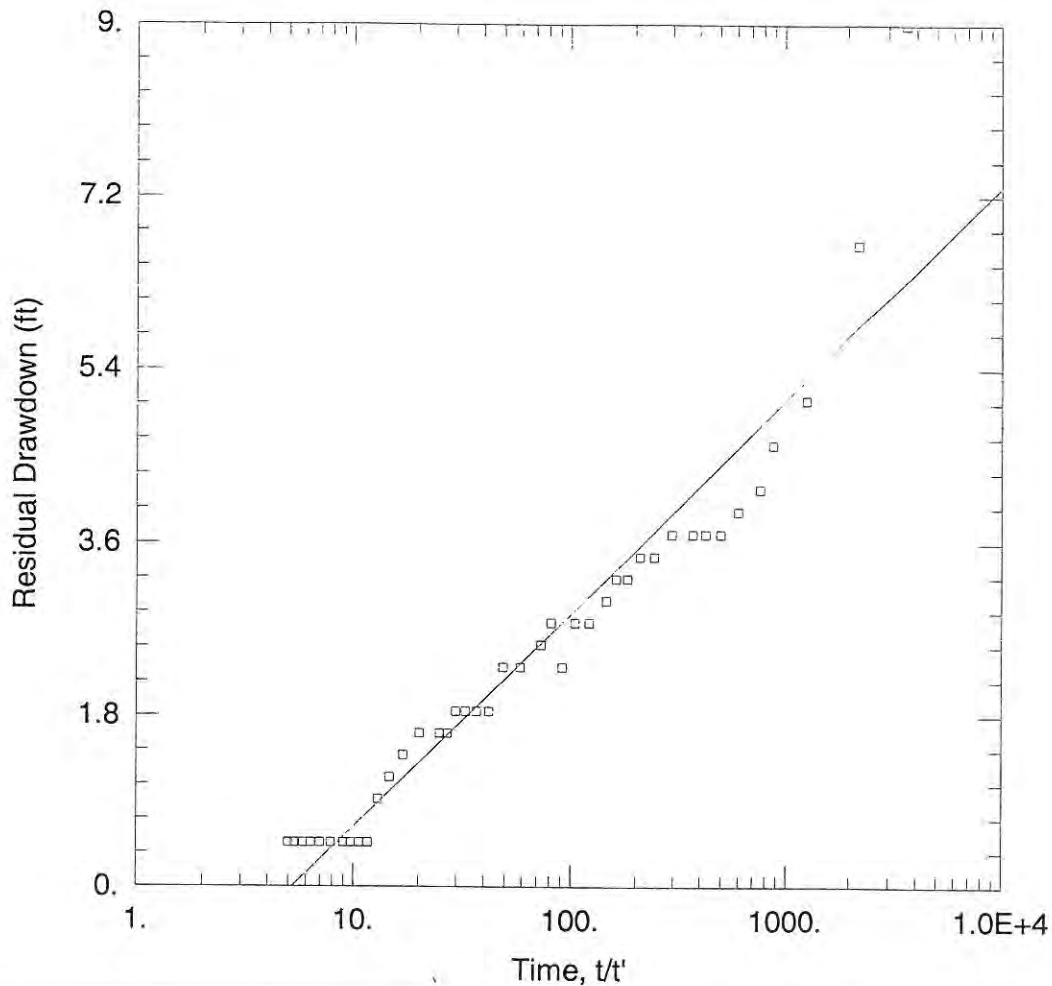
Saturated Thickness: 21. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2	0	0	PZ-107	155	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)
 T = 2.473E+4 gal/day/ft S/S' = 11.45



AAWWTP PUMP TEST - RECOVERY PHASE

Data Set: S:\Waste\HOHNER\AAWWTP\Pump Test Data & Analysis\PT2_REC_202.aqt
 Date: 11/22/06 Time: 13:19:44

PROJECT INFORMATION

Company: NTH
 Client: Malcolm-Pirnie
 Project: 15-050510-06
 Location: Ann Arbor
 Test Well: PW-2
 Test Date: 9-7-06

AQUIFER DATA

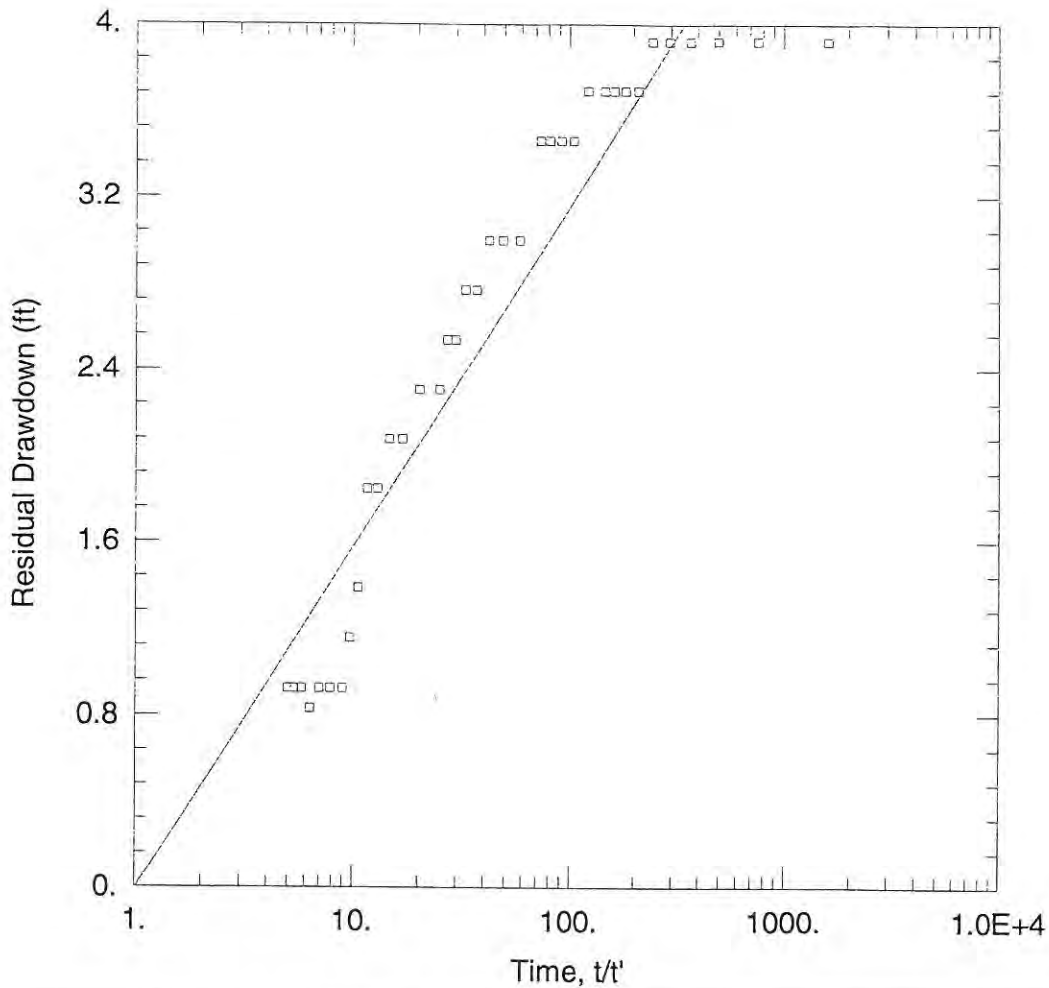
Saturated Thickness: 21. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2	0	0	□ PZ-202	10	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)
 T = 2.491E+4 gal/day/ft S/S' = 5.205



AAWWTP PUMP TEST - RECOVERY PHASE

Data Set: S:\Waste\HOHNER\AAWWTP\Pump Test Data & Analysis\PT2_REC_203.aqt
 Date: 11/22/06 Time: 13:20:32

PROJECT INFORMATION

Company: NTH
 Client: Malcolm-Pirnie
 Project: 15-050510-06
 Location: Ann Arbor
 Test Well: PW-2
 Test Date: 9-7-06

AQUIFER DATA

Saturated Thickness: 21. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

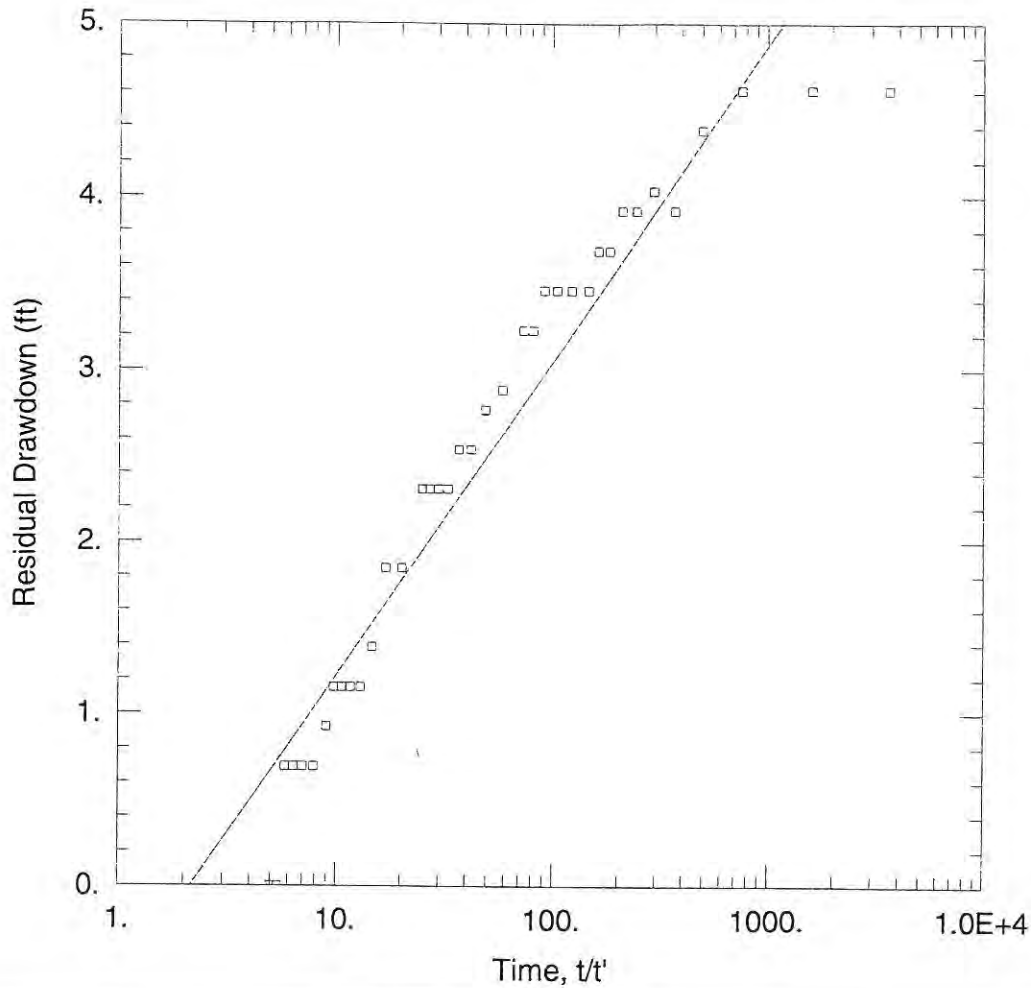
Observation Wells

Well Name	X (ft)	Y (ft)
PW-2	0	0
PW 2	0	0

Well Name	X (ft)	Y (ft)
□ PZ-203	240	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)
 T = 3.504E+4 gal/day/ft S/S' = 1.015



AAWWTP PUMP TEST - RECOVERY PHASE

Data Set: S:\Waste\HOHNER\AAWWTP\Pump Test Data & Analysis\PT2_REC_302.aqt
 Date: 11/22/06 Time: 13:21:00

PROJECT INFORMATION

Company: NTH
 Client: Malcolm-Pirnie
 Project: 15-050510-06
 Location: Ann Arbor
 Test Well: PW-2
 Test Date: 9-7-06

AQUIFER DATA

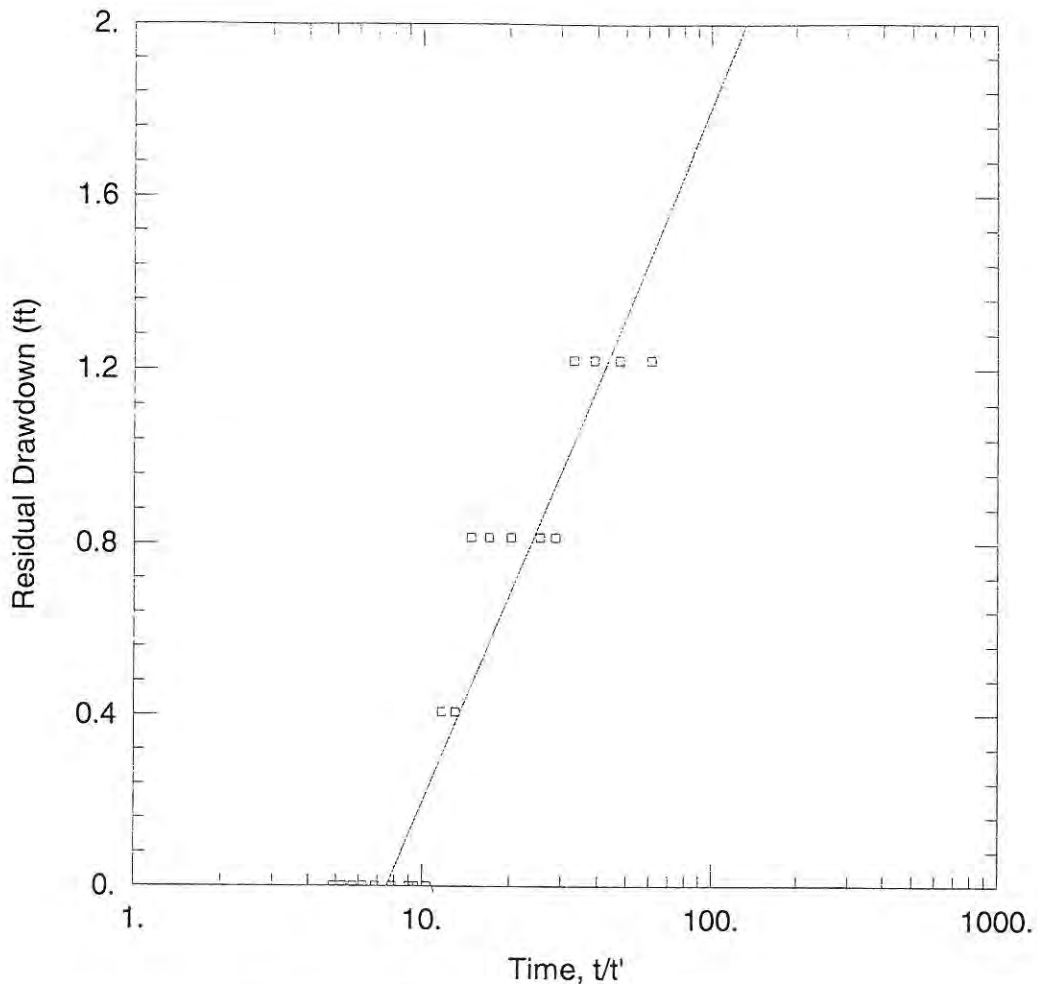
Saturated Thickness: 21. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2	0	0	□ PZ-302	110	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)
 T = 3.032E+4 gal/day/ft S/S' = 2.151



AAWWTP PUMP TEST - RECOVERY PHASE

Data Set: S:\Waste\HOHNER\AAWWTP\Pump Test Data & Analysis\PT2_REC_307.aqt
 Date: 11/22/06 Time: 13:21:24

PROJECT INFORMATION

Company: NTH
 Client: Malcolm-Pirnie
 Project: 15-050510-06
 Location: Ann Arbor
 Test Well: PW-2
 Test Date: 9-7-06

AQUIFER DATA

Saturated Thickness: 21. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Observation Wells

Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
PW-2	0	0	□ PZ-307	390	0

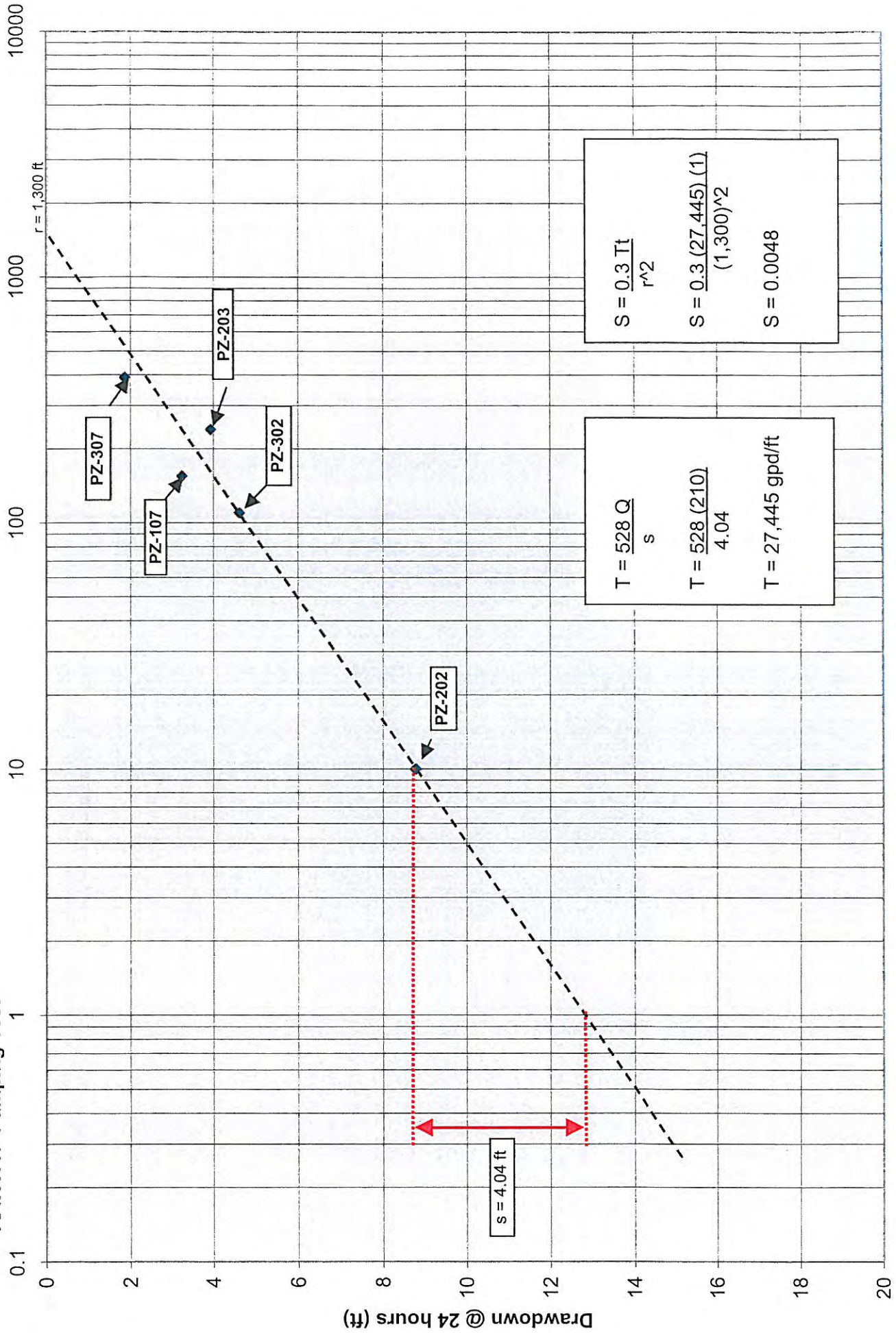
SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)
 T = 3.449E+4 gal/day/ft S/S' = 7.519

DRAFT

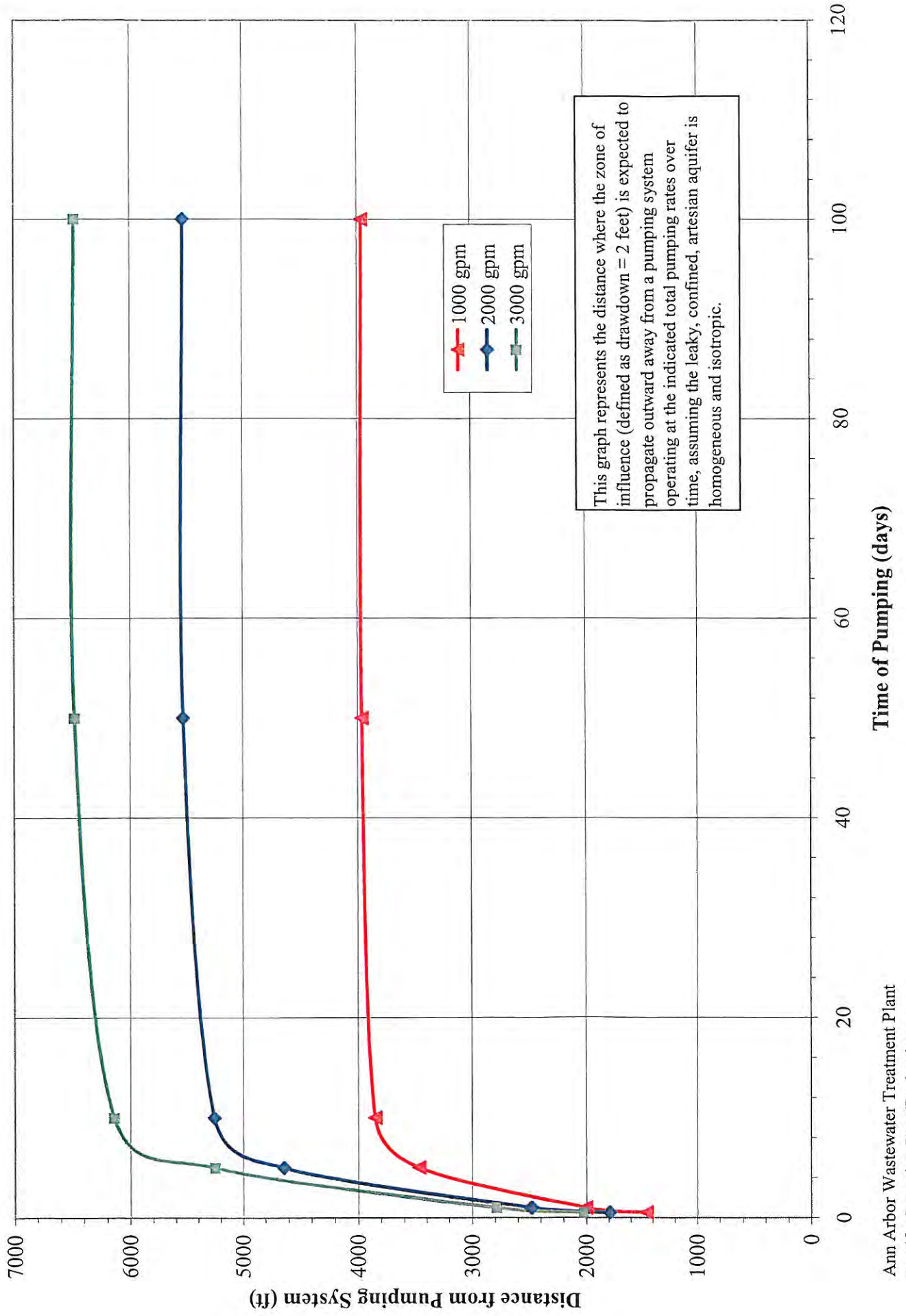
Distance vs. Drawdown AAWWTP Pumping Test

Distance from PW-2 (ft)



Calculated (Theoretical) Zone of Influence vs. Time of Pumping

Ann Arbor Wastewater Treatment Plant



Spiked Sample QC Report

File : C:\HPCHEM\1\DATA\AUG3006.14B\048SPK_.D\048SPK_.D#
 Acquired : Aug 30 06 06:08 pm using AcqMethod DB200_8.M
 Operator : G.J.W.
 Sample Name: BM05314 MS
 Misc Info : DISSOLVED WATER
 Vial Number: 2407
 CurrentMeth: C:\HPCHEM\1\METHODS\DB200_8.M
 BkgFile : -----
 Sample Type: SPIKE
 Dilution : 10.000000

Spike Reference Sample is C:\HPCHEM\1\DATA\AUG3006.14B\047SPKR.D\047SPKR.D#

Spike Recovery

Element	Conc.	Ref. Conc.	Conc. Added	%Rec.	QC Range	Flag
Be 9	1925.000 ug/l	-0.128	2000.0	96	80-120	Spk>Cal
Na 23	28420.000 ug/l	9486.000	20000	95	80-120	Pass
Mg 26	40250.000 ug/l	23080.000	20000	86	80-120	Pass
Al 27	1793.000 ug/l	-22.680	2000.0	90	80-120	Spk>Cal
K 39	21730.000 ug/l	292.300	20000	107	80-120	Pass
Ca 44	112000.000 ug/l	94440.000	20000	88	80-120	High in SR
V 51	1917.000 ug/l	0.541	2000.0	96	80-120	Spk>Cal
Cr 52	1933.000 ug/l	2.936	2000.0	97	80-120	Spk>Cal
Mn 55	1937.000 ug/l	38.970	2000.0	95	80-120	Spk>Cal
Fe 57	21580.000 ug/l	1760.000	20000	99	80-120	Pass
Co 59	1953.000 ug/l	0.089	2000.0	98	80-120	Spk>Cal
Ni 60	1909.000 ug/l	2.980	2000.0	95	80-120	Spk>Cal
Cu 65	1877.000 ug/l	0.705	2000.0	94	80-120	Spk>Cal
Zn 66	1843.000 ug/l	5.631	2000.0	92	80-120	Spk>Cal
As 75	1871.000 ug/l	2.255	2000.0	93	80-120	Spk>Cal
Se 82	1837.000 ug/l	5.239	2000.0	92	80-120	Spk>Cal
Mo 98	2001.000 ug/l	5.173	2000.0	100	80-120	Spk>Cal
Ag 107	19.380 ug/l	0.025	20.000	97	80-120	Pass
Cd 111	1955.000 ug/l	-0.452	2000.0	98	80-120	Spk>Cal
Sb 123	2038.000 ug/l	-0.013	2000.0	102	80-120	Spk>Cal
Ba 137	2217.000 ug/l	171.600	2000.0	102	80-120	Spk>Cal
Tl 205	1941.000 ug/l	-0.359	2000.0	97	80-120	Spk>Cal
Pb 208	1841.000 ug/l	-0.863	2000.0	92	80-120	Spk>Cal

Internal Standard QC Report

ISTD m/z	Ref. Counts	Sample Counts	Flag
6	31747	37390	Pass
45	32262	38559	Pass
115	14774	16886	Pass
209	7583	9305	Pass

Internal Standards referenced to 042SMPL.D#

0 Element Failures. Maximum Number of Failures Allowed (5)
 0 ISTD Failures. Maximum Number of ISTD Failures Allowed (3)

Spiked Sample QC Report

File : C:\HPCHEM\1\DATA\AUG3006.14B\049SPK_.D\049SPK_.D#
 Acquired : Aug 30 06 06:14 pm using AcqMethod DB200_8.M
 Operator : G.J.W.
 Sample Name: BM05314 MSD
 Misc Info : DISSOLVED WATER
 Vial Number: 2408
 CurrentMeth: C:\HPCHEM\1\METHODS\DB200_8.M
 BkgFile : -----
 Sample Type: SPIKE
 Dilution : 10.000000

Spike Reference Sample is C:\HPCHEM\1\DATA\AUG3006.14B\047SPKR.D\047SPKR.D#

Spike Recovery

Element	Conc.	Ref. Conc.	Conc. Added	%Rec.	QC Range	Flag
Be 9	2034.000 ug/l	-0.128	2000.0	102	80-120	Spk>Cal
Na 23	28540.000 ug/l	9486.000	20000	95	80-120	Pass
Mg 26	40160.000 ug/l	23080.000	20000	85	80-120	Pass
Al 27	1837.000 ug/l	-22.680	2000.0	92	80-120	Spk>Cal
K 39	22340.000 ug/l	292.300	20000	110	80-120	Pass
Ca 44	114100.000 ug/l	94440.000	20000	98	80-120	High in SR
V 51	1997.000 ug/l	0.541	2000.0	100	80-120	Spk>Cal
Cr 52	1993.000 ug/l	2.936	2000.0	100	80-120	Spk>Cal
Mn 55	1990.000 ug/l	38.970	2000.0	98	80-120	Spk>Cal
Fe 57	21820.000 ug/l	1760.000	20000	100	80-120	Pass
Co 59	1993.000 ug/l	0.089	2000.0	100	80-120	Spk>Cal
Ni 60	1960.000 ug/l	2.980	2000.0	98	80-120	Spk>Cal
Cu 65	1913.000 ug/l	0.705	2000.0	96	80-120	Spk>Cal
Zn 66	1873.000 ug/l	5.631	2000.0	93	80-120	Spk>Cal
As 75	1923.000 ug/l	2.255	2000.0	96	80-120	Spk>Cal
Se 82	1896.000 ug/l	5.239	2000.0	95	80-120	Spk>Cal
Mo 98	2035.000 ug/l	5.173	2000.0	101	80-120	Spk>Cal
Ag 107	19.580 ug/l	0.025	20.000	98	80-120	Pass
Cd 111	2020.000 ug/l	-0.452	2000.0	101	80-120	Spk>Cal
Sb 123	2085.000 ug/l	-0.013	2000.0	104	80-120	Spk>Cal
Ba 137	2273.000 ug/l	171.600	2000.0	105	80-120	Spk>Cal
Tl 205	2040.000 ug/l	-0.359	2000.0	102	80-120	Spk>Cal
Pb 208	1919.000 ug/l	-0.863	2000.0	96	80-120	Spk>Cal

Internal Standard QC Report

ISTD m/z	Ref. Counts	Sample Counts	Flag
6	31747	36597	Pass
45	32262	37714	Pass
115	14774	16449	Pass
209	7583	8888	Pass

Internal Standards referenced to 042SMPL.D#

0 Element Failures. Maximum Number of Failures Allowed (5)
 0 ISTD Failures. Maximum Number of ISTD Failures Allowed (3)



APPENDIX C

HISTORICAL BORING PLAN

NTH (2006)

TOLTEST, INC. (1997)

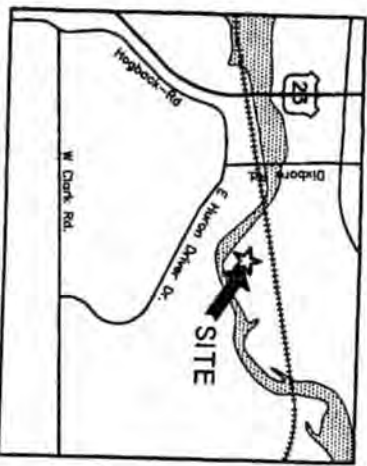
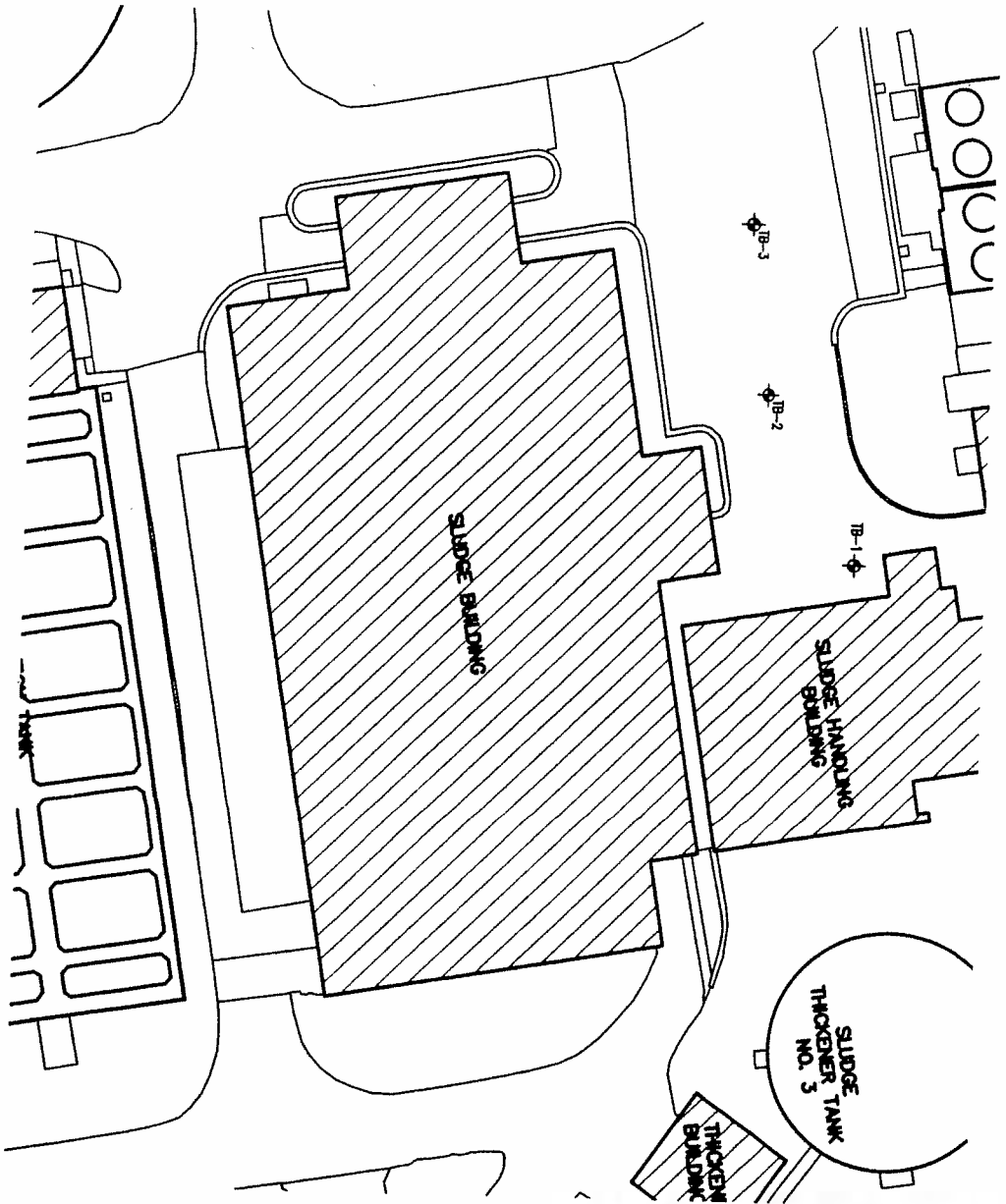
FAIRLANE DRILLING & TESTING CO. (1976-1977)

ATWELL HICKS, INC. (1976)

TEST HOLES AND BORINGS (1935)

DIXBORO ROAD OVER THE HURON RIVER (2001)

WATER WELL RECORD (1969)



LEGEND:
 TEST BORING DRILLED BY
 AMERICAN DRILLING AND TESTING
 CO. ON MARCH 2 AND 23, 2006
 UNDER THE OBSERVATION OF NTH
 CONSULTANTS, LTD.

DRAWING REFERENCE:
 DRAWING TITLED "BORING SITE
 PLAN," BY GREELY AND HANSEN
 L.L.C. DRAWING C1, SHEET 1 OF
 2, PROVIDED TO NTH
 CONSULTANTS, LTD.

1	DATE: 03-29-06	PROJECT NO. 15-050938-00	NTH Consultants, Ltd. Professional Engineering & Environmental Services Farmington Hills Detroit Exton Grand Rapids Lansing	
	SHEET 1 OF 1	SCALE AS SHOWN		
TEST BORING LOCATION PLAN		DRAWN BY: JD		
THICKENER BUILDING ADDITION ARBOR WASTEWATER TREATMENT PLANT ARBOR, MICHIGAN		CHECKED BY:		

LOG OF TEST BOR G NO: TB-1

Project Name: *Ann Arbor Wastewater Treatment Plant-
Proposed Building Addition*
Project Location: *Ann Arbor, Michigan*



NTH CONSULTANTS,

NTH Proj. No: 15-050938

Checked By: *A*

SUBSURFACE PROFILE

SOIL SAMPLE DATA

ELEV. (FT)	PRO-FILE	GROUND SURFACE ELEVATION: 733.5+/-	DEPTH (FT.)	SAMP. TYPE/ NO.	BLOWS/ 6"	STD.PEN. RESIST. (N)	MOIST. CONT. (%)	DRY DENS. (pcf)	UNCONF. COMP.ST. (psf)
		PAVEMENT: ASPHALT	0.2						
		FILL: Brown SAND	1.0						
730		FILL: Medium Compact Dark Brown SAND with Trace of Gravel	3.0	LS-	5 7 9	16			
		Hard Brown SILTY CLAY with Trace of Sand and Gravel	5	LS-1	5 12 17	29			>9000*
725			8.0	LS-2	5 10 15	25			>9000*
			10	LS-3	5 12 17	29	14.4	119.7	16850
720									
		Hard to Very Hard Gray SILTY CLAY with Trace of Sand and Gravel	15	LS-4	11 17 22	39			>9000*
715									
			20	LS-5	15 20 26	46	7.2		>9000*
			22.0						
710		Hard Gray SILTY CLAY with Trace of Sand, Gravel and Occasional Sand Seams	25	LS-6	11 17 30	47			>9000*
			27.0						
705		Very Compact Gray SAND with Trace of Silt and Gravel	30.0	LS-7	8 22 37	59			
		END OF BORING	30						
700			35						

Total Depth: 30 FT
Drilling Date: 03/02/06
Inspector: D. Yip
Contractor: American Drilling & Testing Company
Driller: J. Blank

Water Level Observation:
Groundwater encountered at 24 ft bgs;
at 16 ft bgs upon completion; caved to 24 ft bgs.

Notes:
* - Pocket Penetrometer Value

Drilling Method:
CME-75 all terrain drilling rig with 2-1/4-inch inside-diameter, hollow-stem augers to end of boring.
Plugging Procedure:
Borehole backfilled with excavated material and asphalt patch.

LOG OF TEST BOREHOLE NO: TB-2

Project Name: *Ann Arbor Wastewater Treatment Plant-
Proposed Building Addition*
Project Location: *Ann Arbor, Michigan*



NTH CONSULTANTS,

NTH Proj. No: 15-050938

Checked By: *[Signature]*

SUBSURFACE PROFILE

SOIL SAMPLE DATA

ELEV. (FT)	PRO-FILE	GROUND SURFACE ELEVATION: 735.0+/-	DEPTH (FT.)	SAMP. TYPE/ NO.	BLOWS/ 6"	STD. PEN. RESIST. (N)	MOIST. CONT. (%)	DRY DENS. (pcf)	UNCONF. COMP. ST. (psf)
		PAVEMENT: ASPHALT	0.2						
		FILL: Brown SAND with Trace of Gravel	3.5						
730		FILL: Brown SILTY CLAY with Trace of Sand and Gravel	5	S-1	4 5 12	17			
		Hard Brown and Gray SILTY CLAY with Trace of Sand and Gravel	10	LS-1	6 11 14	25	12.8	120.5	10970
725			10	LS-2	10 15 20	35			>9000*
			15	LS-3	6 13 18	31	8.3	138.3	19660
720			20	LS-4	7 14 16	30	8.6	136.3	16370
715		Hard to Very Hard Gray SILTY CLAY with Trace of Sand and Gravel	25	LS-5	8 16 24	40			>9000*
710			30	LS-6	9 13 22	35			>9000*
705			35	LS-7	9 18 26	44			>9000*
700			36.8						

Total Depth: 40 FT
Drilling Date: 03/23/06
Inspector: D. Yip
Contractor: American Drilling & Testing Company
Driller: J. Blank

Water Level Observation:
*No groundwater encountered;
borehole dry upon completion.*

Drilling Method:
*CME-75 all terrain drilling rig with 2-1/4-inch
inside-diameter, hollow-stem augers to end of boring.*
Plugging Procedure:
*Borehole backfilled with excavated material
and asphalt patch.*

Notes:
* - Pocket Penetrometer Value

LOG OF TEST BORI 3 NO: TB-2

Project Name: *Ann Arbor Wastewater Treatment Plant-
Proposed Building Addition*
Project Location: *Ann Arbor, Michigan*



NTH CONSULTANTS, I

NTH Proj. No: 15-050938-

Checked By: *[Signature]*

SUBSURFACE PROFILE

SOIL SAMPLE DATA

ELEV. (FT)	PRO-FILE	GROUND SURFACE ELEVATION: 735.0+/-	DEPTH (FT.)	SAMP. TYPE/ NO.	BLOWS/ 6"	STD. PEN. RESIST. (N)	MOIST. CONT. (%)	DRY DENS. (pcf)	UNCONF. COMP. ST. (psf)	R
695		Very Hard Gray SILTY CLAY with Trace of Sand and Gravel	40.0	LS-8	14 25 31	56			>9000*	
		END OF BORING								
690			45							
685			50							
680			55							
675			60							
670			65							
665			70							
660			75							
655			80							

LOG OF TEST BOR G NO: TB-3

Project Name: *Ann Arbor Wastewater Treatment Plant-
Proposed Building Addition*
Project Location: *Ann Arbor, Michigan*



NTH CONSULTANTS,

NTH Proj. No: *15-050936*

Checked By: *[Signature]*

SUBSURFACE PROFILE

SOIL SAMPLE DATA

ELEV. (FT)	PRO-FILE	GROUND SURFACE ELEVATION: 736.4+/-	DEPTH (FT.)	SAMP. TYPE/ NO.	BLOWS/ 6"	STD. PEN. RESIST. (N)	MOIST. CONT. (%)	DRY DENS. (pcf)	UNCONF. COMP. ST. (psf)
735		PAVEMENT: ASPHALT	0.2						
		FILL: Brown SAND	1.0						
730		FILL: Dark Brown SAND with Trace of Silt and Gravel	3.0						
		FILL: Medium Compact Brown GRAVELLY SAND with Trace of Silt	5	LS-1	3 5 6	11			
			8.0	LS-2	5 8 8	16			
725		Hard Gray SILTY CLAY with Little Sand and Trace of Gravel	10.0	LS-3	7 13 19	32	18.2	115.2	15760
		Compact Gray SILTY SAND	12.0						
720		Medium to Stiff Gray SILTY CLAY with Trace of Sand and Gravel	14.5						
			15	LS-4	9 16 19	35			
715		Compact Gray SILTY SAND	19.5						
		Very Stiff Gray SILTY CLAY with Trace of Sand, Gravel, Occasional Silt Lenses and Sand Seams	22.0	LS-5	5 9 11	20	20	110.1	5960
710			25	LS-6	9 22 25	47	8.7	139.7	15270
		Hard to Very Hard Gray SANDY CLAY with Trace of Silt, Gravel and Occasional Silt Partings	30	LS-7	17 27 29	58			>9000*
705			35	LS-8	27 32 35	67			>9000*
			36.8						

Total Depth: *40 FT*
Drilling Date: *03/02/06*
Inspector: *D. Yip*
Contractor: *American Drilling & Testing Company*
Driller: *J. Blank*

Water Level Observation:
*Groundwater encountered at 6.5 ft bgs;
at 4.5 ft bgs upon completion; caved to 13.5 ft bgs.*

Notes:
* - Pocket Penetrometer Value

Drilling Method:
*CME-75 all terrain drilling rig with 2-1/4-inch
inside-diameter, hollow-stem augers to end of boring.*
Plugging Procedure:
*Borehole backfilled with excavated material
and asphalt patch.*

GEOLOGIC DRILL LOG			PROJECT	PROJECT NUMBER	SHEET NO.	HOLE NUMBER
29 SOUTH DIXBORO ROAD			ANN ARBOR WWTP	20530.01	1 of 1	B-3
SITE			LOGGED BY	CHECKED BY		
2-3-97			E.S.	E.S.		
BEGUN	COMPLETED	DRILLER	DRILL EQUIPMENT		BORING DIA.	TOTAL DEPTH
2-3-97	3-3-97	N.W. & C.M.	TRUCK MOUNTED ROTARY (DME TS. #111)		4"	10.0 ft.
DRILL METHOD			GROUND ELEV.	DEPTH/ELEV. GROUND WATER		DEPTH/ELEV. TOP OF ROCK
0.25" HOLLOW STEM AUGER				2' DRY / 0.28 1' DRY / 0.28		N/A / na
SAMPLE TYPE			NOTES			
			LOCATION: 18' S. OF LARGER MH. 20' W. OF PAVEMENT			
SAMPLE NUMBER	Depth in Feet	Graphic Log	Sample Number	DESCRIPTION AND CLASSIFICATION		
				density, grain size/shape, color, structure composition, sorting, texture, moisture facies, odor		
				TOPSOIL		
				Moist Dark Brown SILTY CLAY FILL. Some Sand, Little Gravel and Boulder		
	5			Moist Brown SILTY CLAY. Some Sand, Little Gravel		
	10			Bottom of Boring at 10.0 Feet.		
	15					
	20					
	25					
	30					

Figure 1



GEOLOGIC DRILL LOG			PROJECT	PROJECT NUMBER	SHEET NO.	HOLE NUMBER
			ANN ARBOR WWTP	82530.03	1 of 1	B-4
SITE			LOGGED BY		CHECKED BY	
41 SOUTH DIXBORO ROAD			E.S.		E.S.	
BEGUN	COMPLETED	DRILLER	DRILL EQUIPMENT		BORING DIA.	TOTAL DEPTH
3-3-97	3-3-97	N.W. & C.M.	TRUCK MOUNTED ROTARY (CME 75, #111)		4"	10.0 ft.
DRILL METHOD			GROUND ELEV.	DEPTH/ELEV. GROUND WATER	DEPTH/ELEV. TOP OF ROCK	
2 1/2" HOLLOW STEM AUGER				↑ DRY / na ↓ DRY / na	N/A / na	
SAMPLE TYPE			NOTES			
			LOCATION: NEXT TO MAINTENANCE GARAGE			
SAMPLE NUMBER	Depth in Feet	Graphic Log	Sample Number	DESCRIPTION AND CLASSIFICATION density, grain size/shape, color, structure composition, sorting, texture, moisture facies, odor		
	5			TOPSOIL Moist Black-to-Brown SILTY CLAY FILL, Some Sand and Gravel		
	10			Moist Dark Brown SILTY CLAY, Some Sand, Little Gravel		
				<i>Bottom of Boring at 10.0 Feet.</i>		
	15					
	20					
	25					
	30					

Figure 2

GEOLOGIC DRILL LOG		PROJECT	PROJECT NUMBER	SHEET NO.	HOLE NUMBER
SITE		ANN ARBOR WWTP	93530.01	1 of 1	B-5
100 SOUTH DIABORO ROAD		LOGGED BY	CHECKED BY		
BEGUN	COMPLETED	DRILLER	DRILL EQUIPMENT		BORING DIA. TOTAL DEPTH
3-3-97	3-3-97	N.W. & C.M.	TRUCK MOUNTED ROTARY (CME 75. #111)		4" 7.5 ft.
DRILL METHOD		GROUND ELEV.	DEPTH/ELEV. GROUND WATER		DEPTH/ELEV. TOP OF ROCK
PIPE HOLLOW STEM AUGER			2 DRY / na 1 DRY / na		7.5 / na
SAMPLE TYPE		NOTES			
		LOCATION: 10' NORTH OF SEAWALL			
SAMPLE NUMBER	Depth in Feet	Graphic Log	Sample Number	DESCRIPTION AND CLASSIFICATION density, grain size/shape, color, structure composition, sorting, texture, moisture facies, odor	
				TOPSOIL	
				Moist Brown SILTY CLAY FILL, Some Sand and Gravel	
	5			Moist CRUSHED STONE FILL	
				Moist Brown SILTY CLAY FILL, Some Sand, Little Gravel	
				Auger Refusal at 7.5 Feet.	

Figure 3

GEOLOGIC DRILL LOG			PROJECT	PROJECT NUMBER	SHEET NO.	HOLE NUMBER	
SITE			ANN ARBOR WWTP	E2570.01	1 of 1	B-6	
4400 E. 20th Road			LOGGED BY	E.S.			
BEGUN	COMPLETED	DRILLER	DRILL EQUIPMENT			BORING DIA.	TOTAL DEPTH
3-1-97	3-3-97	R.W. G.M.	TRUCK MOUNTED ROTARY CORE TB. #117			4"	10.0 ft.
DRILL METHOD			GROUND ELEV.	DEPTH/ELEV. GROUND WATER	DEPTH/ELEV. TOP OF ROCK		
LINE HOLLOW STEM AUGER			72.1	7.0	10.0		
SAMPLE TYPE			NOTES				
			LOCATION: 80' WEST OF FILLER BUILDING				
SAMPLE NUMBER	Depth in Feet	Graphic Log	Sample Number	DESCRIPTION AND CLASSIFICATION			density, grain size/shape, color, structure composition, sorting, texture, moisture facies, odor
	0			TOPSOIL			
	0			Most Dark Brown SILTY CLAY FILL, Some Sand			
	5			- Grey			
	5			- Brown			
	10			Bottom of Boring at 10.0 Feet.			
	15						
	20						
	25						
	30						

Figure 4

FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 181
GRAND HAVEN, MICHIGAN 49417
AREA 616 - 642-0466

MAIN OFFICE
21337 MORLEY
DEARBORN, MICHIGAN 48124
AREA 313 - 342-7275

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48705
AREA 317 - 736-8446

January 27, 1977

REPORT OF SOIL TEST BORINGS

Project: Proposed City of Ann Arbor - Wastewater Treatment
Plant Additions - Ann Arbor, Michigan

For: McNamee, Porter & Seeley
Consulting Engineers
2223 Packard Road
Ann Arbor, Michigan 48104

On January 19-25, 1977, four (4) additional Soil Test Borings were completed on the above captioned site under our Job No ES-76-082-a. The borings were drilled in accordance with A.S.T.M. Test Method D 1586-67 where by samples of undisturbed soil are recovered in a two (2) inch split spoon or solid type sectional liner samplers, driven by a 140 lb. hammer falling thirty (30) inches. The number of blows required to drive the sampler twelve (12) inches is recorded as the Standard Penetration Resistance. Please note that the sampler was driven eighteen (18) inches, or otherwise specified, and each six (6) inch increment will be found on the Test Boring Reports.

The Test Boring Location Plan along with all recorded field data will be found on the following pages.

Respectfully submitted,

FAIRLANE DRILLING & TESTING CO.


Hubert C. Faltel, Manager

HCF:vf

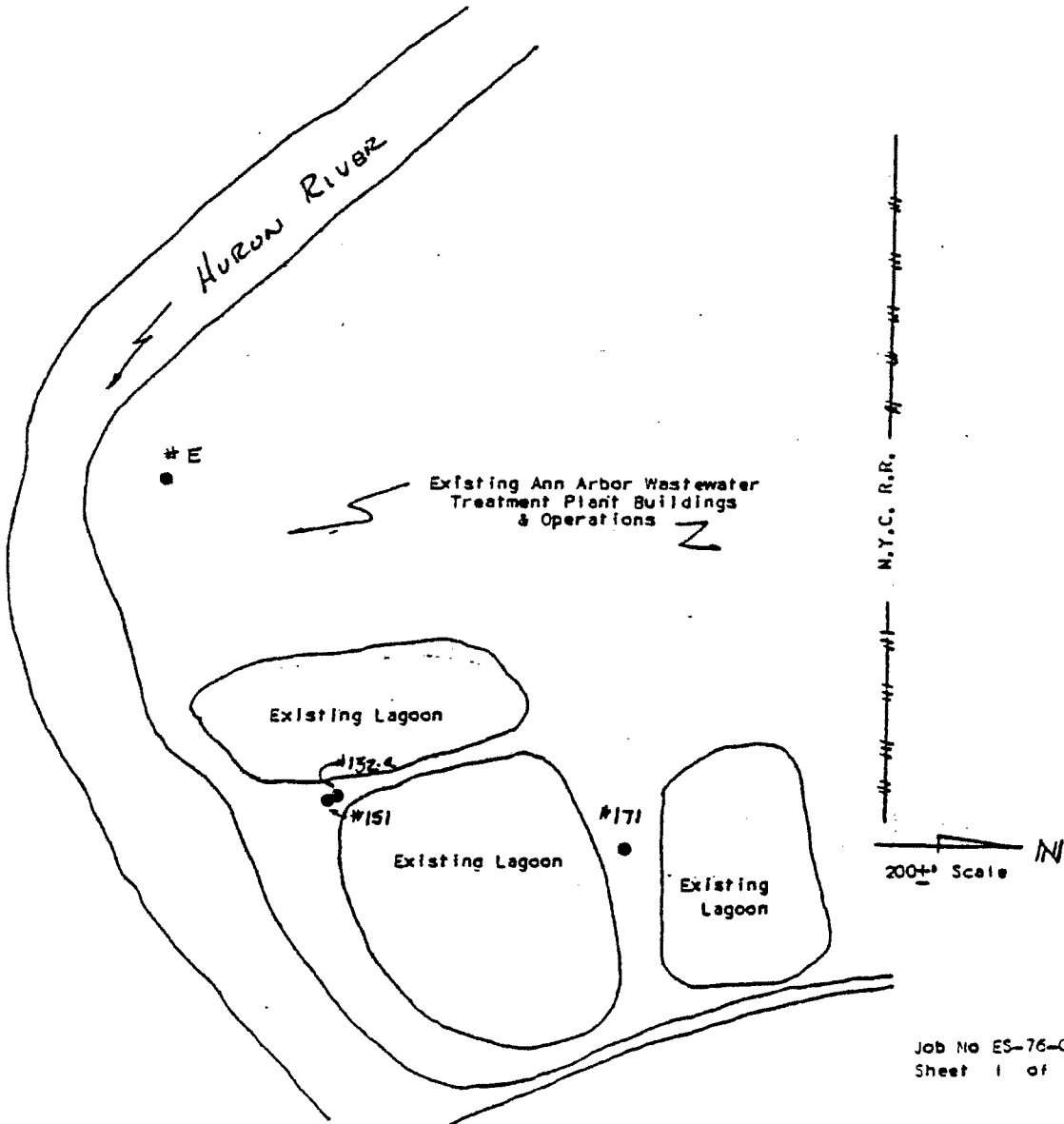
FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 161
GRAND HAVEN, MICHIGAN 49417
AREA 616 - 842-0486

MAIN OFFICE
21837 MORLEY
DEARBORN, MICHIGAN 48124
AREA 313 - 852-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48703
AREA 517 - 736-8446

TEST BORING LOCATION PLAN



Job No ES-76-024-a
Sheet 1 of 4

FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 181
GRAND HAVEN, MICHIGAN 49417
AREA 816 - 842-0468

MAIN OFFICE
21837 MORLEY
DEARBORN, MICHIGAN 48124
AREA 313 - 562-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48705
AREA 817 - 738-8446

TEST BORING REPORT

Soil Test Borings at the site of City of Ann Arbor - Wastewater Treatment Plant

For McNamee, Porter & Seeley - Consulting Engineers

BORING No. 151

Date Started 1-20-77

Ground Surface Elev. 738.8

Date Completed 1-20-77

Datum

Driller H. Faltel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
730	10	2'	SS	5 ₅	Brown SAND GRAVEL & CLAY (f111)	
			SS	3 ₃		
			SS	2 ₃	Treatment Plant Waste	
			SS	3 ₃		
720	20	12'	LS	8 ₁₁	Firm gray "wet" medium SAND & GRAVEL	Water level 8'0" at completion of boring.
			LS	16 ₂₂	Stiff to hard gray CLAY Tr/Sa. & SILT	
		15'	LS	22 ₃₃	Very hard gray CLAY trace of SAND & SILT	
			LS	30 ₅₃		
710	30	24'	LS	100/10"	Very hard gray CLAY trace of SAND & SILT few SANDY SILTY CLAY seams trace of GRAVEL	Backfilled with natural soil after completion.
			LS	100/9"		
			LS	9"		
700	40	34'6"			"Refusal" Probably a COBBLE	
					End of boring	

"N" - Standard Penetration Resistance
S.S. - 2" O.D. Split Spoon Sample
L.S. - Sectional Liner Sample
S.T. - Shelby Tube Sample

Job No. ES-76-082-a

Sheet 2 of 4

FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 181
GRAND HAVEN, MICHIGAN 49417
AREA 416 - 843-0488

MAIN OFFICE
21337 MORLEY
DEARBORN, MICHIGAN 48124
AREA 313 - 363-7173

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48703
AREA 317 - 736-8448

TEST BORING REPORT

Soil Test Borings at the site of City of Ann Arbor - Wastewater Treatment Plant
For: McNamee, Porter & Seeley - Consulting Engineers

BORING No. 171 Date Started 1-19-77
Ground Surface Elev. 739.6 Date Completed 1-19-77
Datum..... Driller H. Faltel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
730	10	3'		4	Brown SAND GRAVEL & CLAY (flll)	GR.
		5'	SS	4	Loose brown CLAYEY coarse SAND some	
		7'6"	SS	2	Treatment Plant Waste	
		11'	SS	8 1/2	Stiff brown CLAY some SAND & GRAVEL seams	
720	20	17'	LS	12	Hard to very hard brown & gray CLAY	Water level 3'0" at completion of boring.
				33		
				38		
710	30	33'	LS	17	Very hard gray CLAY trace of SAND & SILT	Backfilled with natural soil after completion.
				30		
				33		
			LS	30		
700	40	40'	LS	60/3	Very hard gray CLAY trace of SAND SILT & GRAVEL few SANDY SILTY CLAY seams	
				52		
				28		
			LS	46		
			LS	16		
			LS	20		
			LS	30		
			LS	30		
			LS	53		
					End of boring	

"N"—Standard Penetration Resistance
S.S.—2" O.D. Split Spoon Sample
L.S.—Sectional Liner Sample
S.T.—Shelby Tube Sample

Job No. ES-76-082-a
Sheet 3 of 4

FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 181
GRAND HAVEN, MICHIGAN 49437
AREA 516 - 842-0486

MAIN OFFICE
21537 MORLEY
DEARBORN, MICHIGAN 48124
AREA 313 - 562-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48708
AREA 517 - 736-6446

TEST BORING REPORT

Soil Test Borings at the site of City of Ann Arbor - Wastewater Treatment Plant
For: McNamee, Porter & Seeley - Consulting Engineers

BORING No. 152-a Date Started 1-25-77
Ground Surface Elev. 738.8 Date Completed 1-25-77
Datum..... Driller H. Faltel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE TYPE	"N"	SOIL CLASSIFICATION	REMARKS	
730	10	13'6"		7	See Boring No 151	Boring was taken 5' N. of boring No 151.	
			Lost LS	14			22
			LS	18			20
720	20	20'	LS	23	Hard gray CLAY trace of SAND & SILT	Water level 8'0" at completion of boring.	
			LS	35			
710	30		LS	100/7"	Very hard gray CLAY trace of SAND & SILT few SANDY SILTY CLAY layers trace of GRAVEL	Backfilled with Natural soil after completion.	
			LS	100/8"			
			LS	100/11"			
700	40	38'	* 85/		Very compact gray medium to fine SAND some SILT		
		40'	LS	12"			
	0		*		End of boring Bottle sample	No ground water encountered	
							BORING No. E
	5		3"	*	Black PEAT & treatment plant WASTE		
		4'6"	ST	*	Sample Pushed from 2' to 4'6" End of boring		

TN—Standard Penetration Resistance
S.S.—2" O.D. Split Spoon Sample
L.S.—Sectional Linear Sample
S.T.—Shelby Tube Sample

Job No. ES-75-082-4

Sheet 4 of 4

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GRAND HAVEN, MICHIGAN 49417
AREA 616 - 642-0486

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DEARBORN, MICHIGAN 48124
AREA 313 - 562-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48705
AREA 517 - 736-6446

August 11, 1976

REPORT OF SOIL TEST BORINGS

Project: Proposed Wastewater Treatment Plant Improvements
Department of Public Works
City of Ann Arbor, Michigan

For: McNamee, Porter & Seeley
Consulting Engineers
2223 Packard Road
Ann Arbor, Michigan 48104

On August 3-6, 1976, twenty one (21) Soil Test Borings were completed on the above captioned site under our job No ES-76-082. The borings were drilled in accordance with A.S.T.M. Test Method 1586-67 where by samples of undisturbed soil are recovered in a two (2) inch split spoon sampler driven by a 140 lb. hammer falling thirty (30) inches. The number of blows required to drive the sampler twelve (12) inches is recorded as the Standard Penetration Resistance. Please note that the sampler was driven eighteen (18) inches, or otherwise specified, and each six (6) inch increment will be found on the Test Boring Reports.

The Test Boring Location Plan along with all recorded field data will be found on the following pages.

Respectfully submitted,
FAIRLANE DRILLING & TESTING CO.


Hubert C. Fattel, Manager

HCF:vf

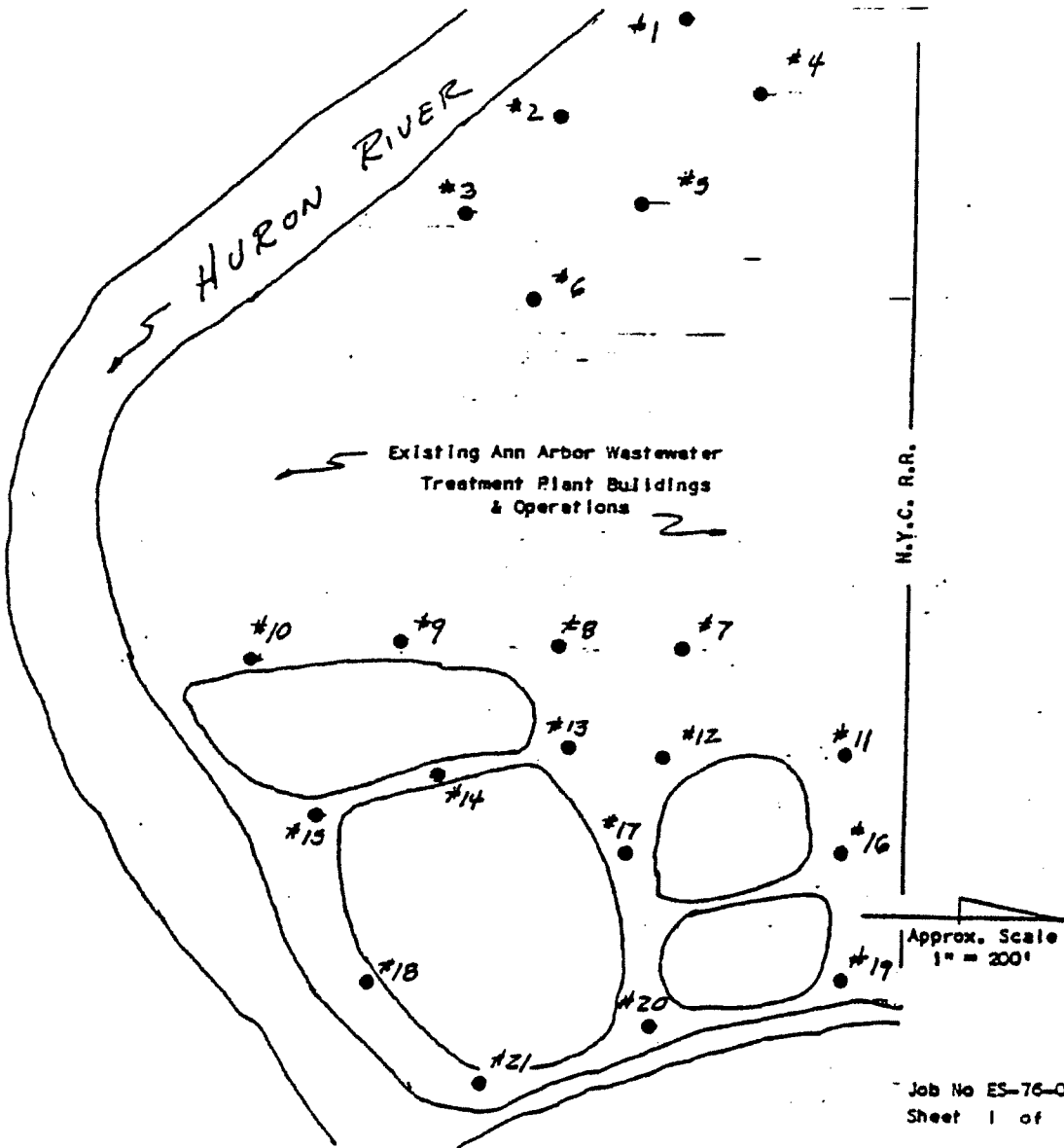
FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 181
GRAND HAVEN, MICHIGAN 49417
AREA 616 - 642-0466

MAIN OFFICE
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DEARBORN, MICHIGAN 48124
AREA 313 - 362-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48702
AREA 517 - 736-6446

TEST BORING LOCATION PLAN



Job No ES-76-082
Sheet 1 of 22

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P. O. BOX 181
GRAND HAVEN, MICHIGAN 48417
AREA 816 - 842-8488

MAIN OFFICE
21337 MORLEY
DEARBORN, MICHIGAN 48124
AREA 313 - 362-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48708
AREA 317 - 738-8448

TEST BORING REPORT

Soil Test Borings at the site of Wastewater Treatment Plant - City of Ann Arbor, Michigan
For McNamee, Porter & Seeley - Consulting Engineers

BORING No. 1 Date Started 8-3-76
Ground Surface Elev. 740.0 Date Completed 8-3-76
Datum Driller H. Faltel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
735	5		SS	10	Hard brown CLAY some SAND coarse GRAVEL & COBBLES	Ground water first encountered below 10' - water level 10'3" at completion of boring.
				22		
				13		
				10		
730	10	9'	SS	11	Very compact coarse SAND & GRAVEL	
				20		
725	15		SS	60/	Compact & very compact brown "wet" coarse SAND & GRAVEL	
				10		
				28		
720	20	21'	SS	60/	Very compact brown "wet" coarse SAND & GRAVEL few SANDY CLAY layers	
				9"		
715	25	25'	SS	60/	End of boring	
				10"		

"N" - Standard Penetration Resistance
S.S. - 2" O.D. Split Spoon Sample
L.S. - Sectional Liner Sample
S.T. - Shelby Tube Sample

Job No. ES-76-082
Sheet 2 of 22

FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 181
GRAND HAVEN, MICHIGAN 49417
AREA 618 - 842-0486

MAIN OFFICE
21327 MORLEY
DEARBORN, MICHIGAN 48124
AREA 313 - 582-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48703
AREA 517 - 736-4446

TEST BORING REPORT

Said Test Borings at the site of Wastewater Treatment Plant - City of Ann Arbor, Michigan
For McNamee, Porter & Seeley - Consulting Engineers

BORING No. 2 Date Started 8-3-76
Ground Surface Elev. 740.4 Date Completed 8-3-76
Datum _____ Driller H. Faltel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS	
			TYPE	"N"			
735	5	5'	SS	13 17 23	Hard CLAY SAND GRAVEL & COBBLES	Water level 9'0" at completion of boring.	
			SS	8 13 18			Compact brown coarse SAND & GRAVEL
			SS	10 10 22			
730	10	9'	SS	60/ 12"	Compact brown "wet" coarse SAND Some GRAVEL		
			SS	60/ 10"			Very hard gray CLAY some SAND SILT & GRAVEL
725	15	13'	SS	60/ 3"	End of boring		
			SS				
720	20		SS				
			SS				
715	25	25'	SS				
			SS				

"N" - Standard Penetration Resistance
S.S. - 2" O.D. Split Spoon Sample
L.S. - Sectional Liner Sample
S.T. - Shelby Tube Sample

Job No. ES-76-082
Sheet 3 of 22

FAIRLANE DRILLING & TESTING CO.

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DEARBORN, MICHIGAN 48124
AREA 313 - 343-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48703
AREA 317 - 736-8446

TEST BORING REPORT

Soil Test Borings at the site of Wastewater Treatment Plant - City of Ann Arbor, Michigan
for: McNamee, Porter & Seeley - Consulting Engineers

BORING No. 3 Date Started..... 8-3-76
Ground Surface Elev..... 736.1 Date Completed..... 8-3-76
Datum..... Driller..... H. Fattel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
735	5	4'	SS	3 2 5	Loose brown medium to coarse SAND & layers of medium CLAY	Water level 5'9" at completion of boring.
730			SS	7 18 28		
725			8'	SS	11 17 13	
720	12'6"	16'	SS	60/ 8"	Very compact gray CLAYEY SILT	
	15'		SS	60/ 7"	Very hard gray CLAY some SAND SILT & GRAVEL	
715	20'				End of boring	

"N"—Standard Penetration Resistance
S.S.—2" O.D. Split Spoon Sample
L.S.—Sectorial Linear Sample
S.T.— Shelby Tube Sample

Job No. ES-76-082
Sheet 4 of 22

FAIRLANE DRILLING & TESTING CO.

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DEARBORN, MICHIGAN 48124
AREA 313 - 582-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48705
AREA 517 - 738-8446

TEST BORING REPORT

Soil Test Borings at the site of Wastewater Treatment Plant - City of Ann Arbor, Michigan
For McNamee, Porter & Seeley - Consulting Engineers

BORING No. 4 Date Started 8-3-76
Ground Surface Elev. 739.1 Date Completed 8-3-76
Datum Driller H. Faltel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
735	5	3'	SS	13	Hard brown CLAY COBBLES & BRICK RUBBLE (f111)	Water level 8'6" at completion of boring.
				12		
				13		
730	8'6"		SS	10	Hard brown CLAY some SAND & GRAVEL	
				15		
				17		
725	12'6"		SS	12	Hard brown SILTY CLAY few "wet" SAND partings	
				13		
				19		
720	18'		SS	60/	Very compact CLAYEY SILT & fine SAND	
				11"		
				10"		
715	21'		SS	60/	Very compact gray "wet" coarse SAND	
				10"		
				9"		
	25'		SS	60/	Very hard gray CLAY some SAND SILT & GRAVEL	
				9"		
					End of boring	

"N" - Standard Penetration Resistance
S.S. - 2" O.D. Split Spoon Sample
L.S. - Sectional Liner Sample
S.T. - Shelby Tube Sample

Job No. ES-76-082
Sheet 5 of 22

FAIRLANE DRILLING & TESTING CO.

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GRAND HAVEN, MICHIGAN 49417
AREA 616 - 542-0488

MAIN OFFICE
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DEARBORN, MICHIGAN 48124
AREA 312 - 362-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48708
AREA 317 - 738-6448

TEST BORING REPORT

Soil Test Borings at the site of Wastewater Treatment Plant - City of Ann Arbor, Michigan
For McNamee, Porter & Seeley - Consulting Engineers

BORING No. 5 Date Started 8-3-76
Ground Surface Elev. 738.2 Date Completed 8-3-76
Datum Driller H. Faltel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
735	5	6'6"	SS	10 12 12	Hard clay GRAVEL & RUBBLE (f111)	Water level 7'10" at completion of boring.
			SS	11 30/ 4"		
730	9'		SS	20 20 28	Hard brown SANDY GRAVELLY CLAY & layers of "wet" SAND & GRAVEL	
725	10		SS		Hard gray CLAY few SILT partings	
720	15	16'	SS	20 35	Very compact gray fine SILTY SAND	
			SS	60/ 10"	Very hard gray CLAY some SAND SILT & GRAVEL	
715	25'		SS	60/ 6"		
	25'				End of boring	

"N" - Standard Penetration Resistance
S.S. - 2" O.D. Split Spoon Sample
L.S. - Sectional Linear Sample
S.T. - Shelby Tube Sample

Job No. ES-76-082
Sheet 6 of 22

FAIRLANE DRILLING & TESTING CO.

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P. O. BOX 181
GRAND HAVEN, MICHIGAN 49417
AREA 816 - 842-0486

MAIN OFFICE
21537 MORLEY
DEARBORN, MICHIGAN 48124
AREA 313 - 562-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48705
AREA 817 - 736-8446

TEST BORING REPORT

Soil Test Borings at the site of Wastewater treatment Plant - City of Ann Arbor, Michigan

For McNamee, Porter & Seeley - Consulting Engineers

BOILING No. 6
Ground Surface Elev. 735.0
Datum

Date Started. 8-3-76
Date Completed. 8-3-76
Driller. H. Faltel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
730	4'		SS	7 9 9	Hard brown CLAY coarse GRAVEL & COBBLES	Water level 7'8" at completion of boring.
				3 8 15		
725	8'	10'6"	SS	60/ 12"	Firm brown coarse SAND & GRAVEL	
				18 22 30	Very compact brown "wet" coarse SAND & GRAVEL	
720	15'		SS	17 20 22	Hard to very hard gray CLAY some SAND SILT & GRAVEL	
715	20'		SS		End of boring	

"N" - Standard Penetration Resistance
S.S. - 2" O.D. Split Spoon Sample
L.S. - Sectional Linear Sample
S.T. - Shelby Tube Sample

Job No. ES-76-082
Sheet 7 of 22

FAIRLANE DRILLING & TESTING CO.

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AREA 313 - 362-7373

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 49705
AREA 517 - 736-8446

TEST BORING REPORT

Soil Test Borings at the site of Wastewater Treatment Plant - City of Ann Arbor, Michigan
For McNamee, Porter & Seeley - Consulting Engineers

BORING No. 7 Date Started 8-6-76
Ground Surface Elev. 741.4 Date Completed 8-6-76
Datum Driller H. Faltel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
740				9	Hard brown SANDY GRAVELLY CLAY	Water level 5'10" at completion of boring.
			SS	17		
				18		
735	5			8	Firm brown "wet" SAND & GRAVEL	
			SS	38		
		7'6"		5	Hard brown CLAY little SAND & SILT	
		8'6"		7		
730	10		SS	16		
				18	Hard to very hard gray CLAY little SAND SILT & GRAVEL	
			SS	50		
725	15	17'		12		
			SS	24		
720	20			12	End of boring	
				19		
715	25	25'	SS	35		

"N"—Standard Penetration Resistance
S.S.—2" O.D. Split Spoon Sample
L.S.—Sectional Liner Sample
S.T.—Shelby Tube Sample

Job No. ES-76-082
Sheet 8 of 22

FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 181
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AREA 816 - 843-0486

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DEARBORN, MICHIGAN 48124
AREA 313 - 343-7373

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48708
AREA 517 - 736-6448

TEST BORING REPORT

Soil Test Borings at the site of Wastewater Treatment Plant - Ann Arbor, Michigan
For: McNamee, Porter & Seeley - Consulting Engineers

BORING No. 8 Date Started 8-5-76
Ground Surface Elev. 737.9 Date Completed 8-5-76
Datum Driller H. Faltel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
735	5		SS	6 6 5	Medium brown & dark brown LOAMY CLAY few SAND seams	Water level 4'9" at completion of boring.
				4 7 10		
730	7'	7'	SS	10	Firm brown "wet" SAND GRAVEL & Cobbles	
		8'		20 23	Hard brown CLAY little SAND & GRAVEL	
725	10	12'	SS	12	Hard brown CLAY trace of SAND & SILT	
				18 24		
720	15	16'6"		15	Hard gray CLAY little SAND SILT & GRAVEL	
				22 29		
715	20	20'	SS		End of boring	

7" - Standard Penetration Resistance
S.S. - 2" O.D. Split Spoon Sample
L.S. - Sectional Liner Sample
S.T. - Shelby Tube Sample

Job No. ES-76-082
Sheet 9 of 22

FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 181
GRAND HAVEN, MICHIGAN 48417
AREA 516 - 843-0488

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AREA 313 - 582-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48708
AREA 517 - 738-6448

TEST BORING REPORT

Sell Test Borings at the site of Wastewater Treatment Plant - City of Ann Arbor, Michigan

For McNamee, Porter & Seeley - Consulting Engineers

BORING No. 9

Date Started..... 8-3-76

Ground Surface Elev..... 738.6

Date Completed..... 8-3-76

Datum.....

Driller..... H. Faltel

ELEV.	DEPTH	STRATA CHANGES	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
735	5	3'6"	SS	20/ 6"	Hard brown clay GRAVEL & COBBLES (f111)	Water level 6'0" at completion of boring.
730			SS	4 4 5	Medium discolored CLAY & Treatment Plant ASH (f111)	
725	10	8'6"	SS	5 9 12	Stiff to hard brown CLAY trace of SAND & PEBBLES	
			SS	20 32		
720	15	16'6"	SS	60/ 9"	Very hard gray CLAY little SAND SILT & GRAVEL	
715	20	21'	SS	9"	End of boring	
	25					

"N"—Standard Penetration Resistance
S.S.—2" O.D. Split Spoon Sample
L.S.—Sectional Linner Sample
S.T.—Shelby Tube Sample

Job No. ES-76-082

Sheet 10 of 22

10

FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 181
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AREA 616 - 642-0446

MAIN OFFICE
21827 MORLEY
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AREA 313 - 343-7275

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48705
AREA 517 - 736-4446

TEST BORING REPORT

Soil Test Borings at the site of Wastewater Treatment Plant - City of Ann Arbor, Michigan
For McNamee, Porter & Seeley - Consulting Engineers

BORING No. 10 Date Started. 8-4-76
Ground Surface Elev. 737.7 Date Completed. 8-4-76
Datum Driller. H. Fattel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
735	5	5'	SS	3 8 8	Stiff brown SANDY GRAVELLY CLAY (fiii)	Water level 8'6" at completion of boring.
730			SS	2 2 4		
725	10	9'6"	SS	4 4 6	Loose discolored "wet" medium SAND & GRAVEL	
715	20	22'	SS	7 12 18	End of boring	
			25			

"N" - Standard Penetration Resistance
S.S. - 2" O.D. Split Spoon Sample
L.S. - Sectional Liner Sample
S.T. - Shelby Tube Sample

Job No. ES-76-082
Sheet 11 of 22

FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 181
GRAND HAVEN, MICHIGAN 49417
AREA 516 - 442-0484

MAIN OFFICE
21827 MORLEY
DEARBORN, MICHIGAN 48124
AREA 313 - 562-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48705
AREA 517 - 736-4444

TEST BORING REPORT

Soil Test Borings at the site of Wastewater Treatment Plant - City of Ann Arbor, Michigan

For McNamee, Porter & Seeley - Consulting Engineers

BORING No. 11

Date Started 8-6-76

Ground Surface Elev. 747.8

Date Completed 8-6-76

Datum

Driller H. Faltel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
745	4'		SS	3	Loose brown coarse GRAVEL SANDY CLAY & COBBLES	Ground water first encountered below 10' - water level 13' at completion of boring.
				4		
				5		
740	8'		SS	9	Compact brown fine SILTY SAND	
				15		
				17		
735	13'		SS	8	Firm brown fine SILTY SAND & layers of hard CLAY	
				8		
				17		
730	16'		SS	7	Compact brown "wet" fine SAND	
				13		
				14		
725	23'		SS	17	Compact gray "wet" fine SAND & layers of very hard CLAY	
				55		
				18		
720	25'		SS	22	Hard to very hard gray CLAY little SAND SILT & GRAVEL	
				20		
						End of boring

"N" - Standard Penetration Resistance
S.S. - 2" O.D. Split Spoon Sample
L.S. - Sectional Linear Sample
S.T. - Shelby Tube Sample

ES-76-082

Job No. _____

Sheet 12 of 22

12

FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 181
GRAND HAVEN, MICHIGAN 48417
AREA 616 - 842-0486

MAIN OFFICE
21537 MORLEY
DEARBORN, MICHIGAN 48124
AREA 313 - 362-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48708
AREA 517 - 736-8448

TEST BORING REPORT

Soil Test Borings at the site of Wastewater Treatment Plant - City of Ann Arbor, Michigan
 For McNemee, Porter & Seeley - Consulting Engineers

BORING No. 12 Date Started 8-5-76
 Ground Surface Elev. 741.0 Date Completed 8-5-76
 Datum Driller H. Faltel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
740				2	Brown & black Treatment Plant ASH (fill)	Water level 3'6" at completion of boring.
			SS	1		
				1		
735	5		SS	1		
		8'		15	Compact brown "wet" coarse SAND & GRAVEL	
730	10	11'	SS	15		
				12	Hard brown CLAY trace of SAND & SILT	
			SS	23		
725	15			35		
		16'6"		16	Hard to very hard gray CLAY little SAND SILT & GRAVEL	
				23		
720	20	20'	SS	38		
					End of boring	

"N"—Standard Penetration Resistance
 S.S.—2" O.D. Split Spoon Sample
 L.S.—Sectional Liner Sample
 S.T.—Shelby Tube Sample

Job No. ES-76-882
 Sheet 13 of 22

FAIRLANE DRILLING & TESTING CO.

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GRAND HAVEN, MICHIGAN 48417
AREA 516 - 842-0486

MAIN OFFICE
21537 MORLEY
DEARBORN, MICHIGAN 48124
AREA 313 - 562-7275

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48703
AREA 517 - 736-6446

TEST BORING REPORT

Soil Test Borings at the site of Wastewater Treatment Plant - City of Ann Arbor, Michigan

For: McNamee, Porter & Seeley - Consulting Engineers

BORING No. 13
Ground Surface Elev. 738.1
Datum

Date Started. 8-4-76
Date Completed. 8-4-76
Driller H. Faltel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
735	5	5'	SS	1 3 3	Medium CLAY & Treatment Plant ASH (f1111).	Water level 2'9" at completion of boring.
			SS	1 2 4		
			SS	11 20 24		
730	10	8'6"	SS	11 18 25	Hard brown CLAY trace of SAND & SILT	
			SS	17 22 28		
			SS	17 22 28		
725	15	17'	SS	17 22 28	Hard to very hard gray CLAY little SAND SILT & GRAVEL	
			SS	17 22 28		
			SS	17 22 28		
720	20	20'	SS	17 22 28	End of boring	
			SS	17 22 28		
			SS	17 22 28		
715						

"N" - Standard Penetration Resistance
S.S. - 2" O.D. Split Spoon Sample
L.S. - Sectional Linear Sample
S.T. - Shelby Tube Sample

Job No. ES-76-082
Sheet 14 of 22

FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 181
GRAND HAVEN, MICHIGAN 49417
AREA 616 - 842-0486

MAIN OFFICE
21937 MORLEY
DEARBORN, MICHIGAN 48124
AREA 313 - 342-7375

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48708
AREA 517 - 736-8446

TEST BORING REPORT

Soil Test Borings at the site of Wastewater Treatment Plant - City of Ann Arbor, Michigan

For McNamee, Porter & Seeley - Consulting Engineers

BOILING No. 14 Date Started 8-4-76
Ground Surface Elev. 738.9 Date Completed 8-4-76
Datum _____ Driller H. Faltel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
735	5	4'6"		4	Medium to stiff brown SANDY CLAY some GRAVEL	Water level 5'6" at completion of boring.
			SS	6		
			SS	6		
730	10	8'6"		1	Organic CLAY & Treatment Plant ASH (fiii)	
			SS	1		
			SS	1		
725	15	11'		12	Compact gray "wet" coarse SAND & GRAVEL	
			SS	14		
			SS	21		
720	20	20'		10	Hard to very hard gray CLAY little SAND SILT & GRAVEL	
			SS	21		
			SS	24		
				15		
			SS	40		
					End of boring	

"N"—Standard Penetration Resistance
S.S.—2" O.D. Split Spoon Sample
L.S.—Sectional Liner Sample
S.T.—Shelby Tube Sample

Job No. ES-76-082
Sheet 15 of 22

15

FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 181
GRAND HAVEN, MICHIGAN 48417
AREA 516 - 843-8486

MAIN OFFICE
21527 MORLEY
DEARBORN, MICHIGAN 48124
AREA 313 - 563-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48708
AREA 817 - 736-8446

TEST BORING REPORT

Soil Test Borings at the site of Wastewater Treatment Plant - City of Ann Arbor, Michigan

For McNamee, Porter & Seeley - Consulting Engineers

BORING No. 15
Ground Surface Elev. 738.2
Datum

Date Started 8-4-76
Date Completed 8-4-76
Driller H. Fattel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
735	5	4'6"	SS	3	Medium brown SANDY GRAVELLY CLAY (fill)	Water level 9'0" at completion of boring.
				3		
				6		
730	8'		SS	2	Loose dark brown & black treatment Plant ASH (fill)	
				2		
				3		
725	10		SS	1	Loose black coarse SAND Possible fill	
				2		
				3		
720	15		SS	8	Hard gray CLAY some SAND SILT & GRAVEL	
				7		
				18		
715	20	21'	SS	8	End of boring	
				14		
				32		

"N" - Standard Penetration Resistance
S.S. - 2" O.D. Split Sosen Sample
L.S. - Sectional Linear Sample
S.T. - Shelby Tube Sample

Job No. ES-76-082

Sheet 16 of 22

16

FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 181
GRAND HAVEN, MICHIGAN 48417
AREA 818 - 842-0486

MAIN OFFICE
21337 MORLEY
DEARBORN, MICHIGAN 48124
AREA 313 - 542-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48708
AREA 517 - 736-8446

TEST BORING REPORT

Sold Test Borings at the site of Wastewater Treatment Plant - City of Ann Arbor, Michigan
For McNamee, Porter & Seeley - Consulting Engineers

BORING No. 16 Date Started 8-5-76
Ground Surface Elev. 741.4 Date Completed 8-5-76
Datum..... Driller H. Faltel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
740				5	Brown & black treatment plant ASH (fill)	Water level 8'0" at completion of boring.
			SS	6 7		
	4'			4	Nested BOULDERS & COBBLES	
735	5		SS	4 7		
	7'			14	Compact brown "wet" coarse SAND & GRAVEL	
730	10		SS	30		
	12'			14	Hard brown CLAY trace of SAND & PEBBLES	
725	15		SS	28		
	16'6"			12	Hard to very hard gray CLAY little SAND SILT & GRAVEL	
			SS	17 20		
720	20			50/		
			SS	11"		
715	25			60/		
	30'		SS	8"		
710	30				End of boring	

"N"—Standard Penetration Resistance
S.S.—2" O.D. Split Spoon Sample
L.S.—Sectional Liner Sample
S.T.—Shelby Tube Sample

Job No. ES-76-082

Sheet 17 of 22

FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 181
GRAND HAVEN, MICHIGAN 49417
AREA 616 - 842-0486

MAIN OFFICE
21327 MORLEY
DEARBORN, MICHIGAN 48124
AREA 313 - 582-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48708
AREA 517 - 738-8446

TEST BORING REPORT

Soil Test Borings at the site of Wastewater Treatment Plant - City of Ann Arbor, Michigan

For McNamee, Porter & Seeley - Consulting Engineers

BORING No. 17

Date Started 8-4-76

Ground Surface Elev. 740.1

Date Completed 8-4-76

Datum

Driller H. Faltel

ELEV.	DEPTH	STRATA CHANGES	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	NO.		
735	5	4'	SS	3	Treatment Plant ASH (fill)	Water level 3'9" at completion of boring.
				4		
				5		
730	10	7'	SS	1	Soft black ORGANIC CLAY's "wet" coarse SAND	
				1		
725	15		SS	7	Hard brown CLAY trace of SAND & SILT	
				15		
				24		
				24		
720	20	18'	SS	13	Hard to very hard gray CLAY little SAND SILT & GRAVEL	
				21		
				38		
715	25	26'	SS	9	Hard to very hard gray CLAY little SAND SILT & GRAVEL	
				15		
				22		
			SS	13	End of boring	
				23		
				40		

"N" - Standard Penetration Resistance
S.S. - 2" O.D. Split Spoon Sample
L.S. - Sectional Liner Sample
S.T. - Shelby Tube Sample

Job No. ES-76-082

Sheet 18 of 22

FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 181
GRAND HAVEN, MICHIGAN 48417
AREA 616 - 842-6488

MAIN OFFICE
21827 MORLEY
DEARBORN, MICHIGAN 48126
AREA 313 - 582-7278

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48708
AREA 517 - 736-6446

TEST BORING REPORT

Soil Test Borings at the site of Wastewater Treatment Plant - City of Ann Arbor, Michigan

For McNamee, Porter & Seeley - Consulting Engineers

BORING No. 18

Date Started 8-6-76

Ground Surface Elev. 739.0

Date Completed 8-6-76

Drum.....

Driller H. Faltel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
735	4'		SS	15/24	Brown CLAY coarse GRAVEL & COBBLES (f1111)	Water level 9'6" at completion of boring.
				3		
730	8'		SS	3	Black ORGANIC CLAY & Treatment Plant ASH (f1111)	
				5		
725	12'		SS	1	Loose gray "wet" medium SAND some coarse GRAVEL	
				3		
720	17'		SS	5	Stiff gray CLAY trace of SAND & PEBBLES	
				7		
720	20'		SS	12	Hard to very hard gray CLAY little SAND SILT & GRAVEL	
				22		
			SS	33	End of boring	

"N" - Standard Penetration Resistance
S.S. - 2" O.D. Split Spoon Sample
L.S. - Sectional Linear Sample
S.T. - Shelby Tube Sample

Job No. ES-76-082

Sheet 19 of 22

19

FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 181
GRAND HAVEN, MICHIGAN 49417
AREA 616 - 642-0486

MAIN OFFICE
21827 MORLEY
DEARBORN, MICHIGAN 48124
AREA 313 - 542-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48708
AREA 517 - 736-6444

TEST BORING REPORT

Soil Test Borings at the site of Wastewater Treatment Plant - City of Ann Arbor, Michigan
For: McNamee, Porter & Seeley - Consulting Engineers

BORING No. 19 Date Started. 8-6-76
Ground Surface Elev. 738.9 Date Completed. 8-6-76
Datum Driller. H. Faltel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
735			SS	4 4 4	Brown & Black treatment Plant ASH (fiii)	Some ground water was encountered at 8'0" - boring was dry at completion.
	5	5'	SS	1 3 3		
730		8'			Loose brown "wet" medium SAND little GRAVEL	
	10		SS	9 15 25	Hard brown CLAY trace of SAND & SILT	
725		13'				
	15		SS	9 17 25	Hard to very hard gray CLAY little SAND SILT & GRAVEL	
720						
	20		SS	60/ 9"		
715					End of boring	
	25	26'	SS	60/ 9'		
710						
	30					

"N" - Standard Penetration Resistance
S.S. - 2" O.D. Split Spoon Sample
L.S. - Sectional Liner Sample
S.T. - Shelby Tube Sample

Job No. ES-76-082
Sheet 20 of 22

20

FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 181
GRAND HAVEN, MICHIGAN 49417
AREA 616 - 842-0486

MAIN OFFICE
21537 MORLEY
DEARBORN, MICHIGAN 48124
AREA 373 - 542-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48705
AREA 517 - 736-6446

TEST BORING REPORT

Soil Test Borings at the site of: Wastewater Treatment Plant - City of Ann Arbor, Michigan
For: McNamee, Porter & Seeley - Consulting Engineers

BOILING No. 20 Date Started 8-6-76
Ground Surface Elev. 740.7 Date Completed 8-6-76
Datum Driller H. Faltel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
735	5	6'6"	SS	30/2"	Treatment Plant ASH CLAY coarse GRAVEL & COBBLES (f111)	Water level 7'2" at completion of boring.
			SS	3 2 5		
730	10	12'	SS	9 12 28	Compact brown "wet" coarse SAND & GRAVEL	
			SS	14 17 19	Hard gray CLAY little SAND SILT & GRAVEL	
725	15	15'	SS		End of boring	

"N"—Standard Penetration Resistance
S.S.—2" O.D. Split Spoon Sample
L.S.—Sectional Liner Sample
S.T.—Shelby Tube Sample

Job No. ES-76-082
Sheet 21 of 22

FAIRLANE DRILLING & TESTING CO.

GRAND RAPIDS AREA
P. O. BOX 181
GRAND HAVEN, MICHIGAN 49417
AREA 616 - 642-0486

MAIN OFFICE
21327 MORLEY
DEARBORN, MICHIGAN 48124
AREA 313 - 562-7273

ALPENA AREA
WEST TRASK LAKE ROAD
BARTON CITY, MICHIGAN 48768
AREA 317 - 736-6446

TEST BORING REPORT

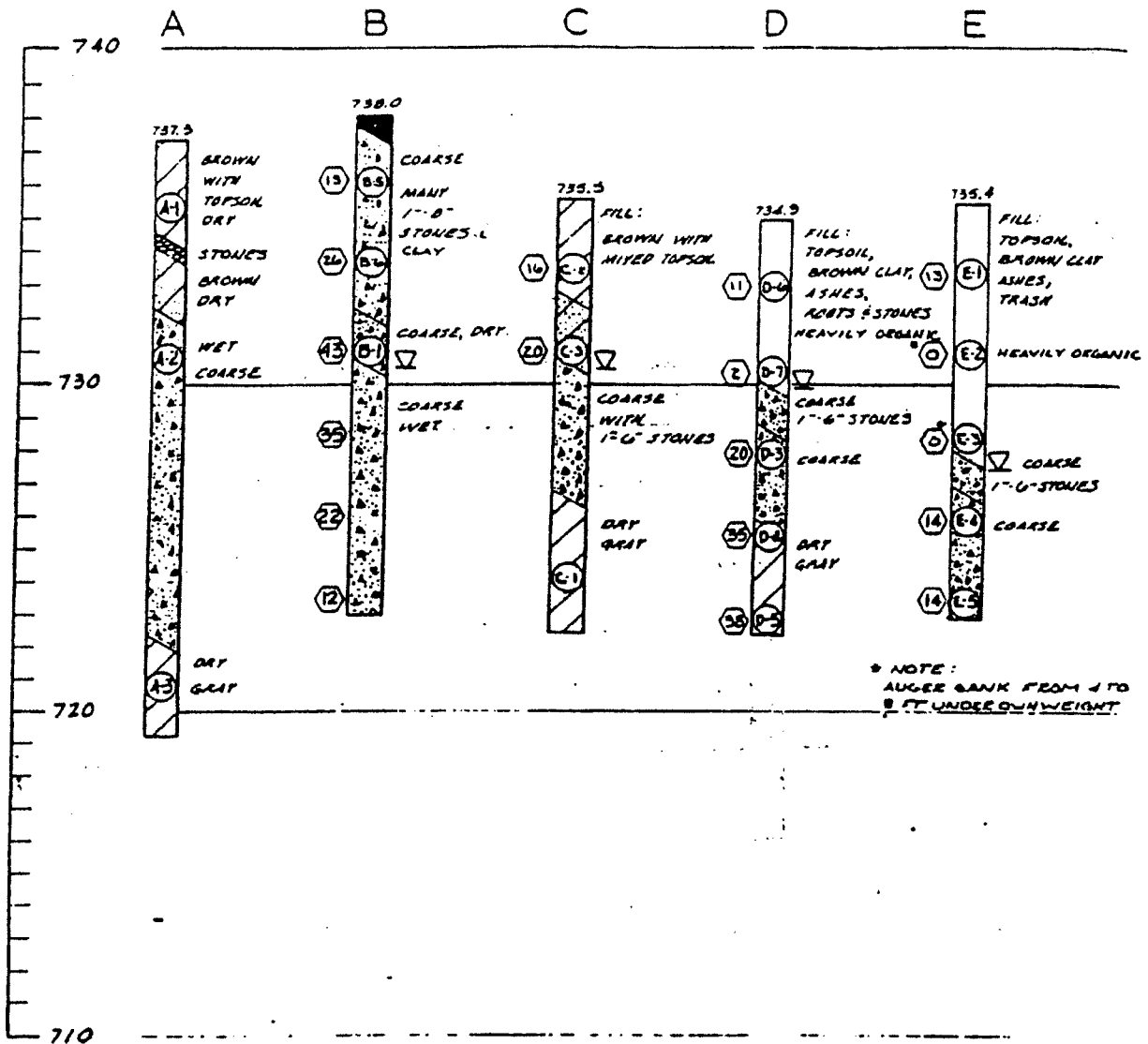
Said Test Borings at the site of Wastewater Treatment Plant - City of Ann Arbor, Michigan
For: McNamee, Porter & Seeley - Consulting Engineers

BORING No. 21 Date Started 8-5-76
Ground Surface Elev. 738.9 Date Completed 8-5-76
Datum Driller H. Faltel

ELEV.	DEPTH	STRATA CHANGE	SAMPLE		SOIL CLASSIFICATION	REMARKS
			TYPE	"N"		
735	4'		SS	11	Brown CLAY coarse SAND GRAVEL & COBBLES	Water level 9'3" at completion of boring.
				22		
730	5'	7'6"	SS	2	Black PEATY CLAY & Treatment Plant ASH (fiii)	
				4		
725	10'	10'6"	SS	7	Compact brown "wet" coarse SAND & GRAVEL	
				17		
720	15'	13'6"	SS	28	Nested coarse GRAVEL & COBBLES	
				7		
720	17'		SS	17	Compact brown & gray "wet" fine SILTY SAND	
				28		
20'			SS	12	Hard to very hard gray CLAY little SAND SILT & GRAVEL	
				22		
			SS	33	End of boring	

"N"—Standard Penetration Resistance
S.S.—2" O.D. Split Spoon Sample
L.S.—Sectional Linner Sample
S.T.—Shelby Tube Sample

Job No. ES-76-082
Sheet 22 of 22

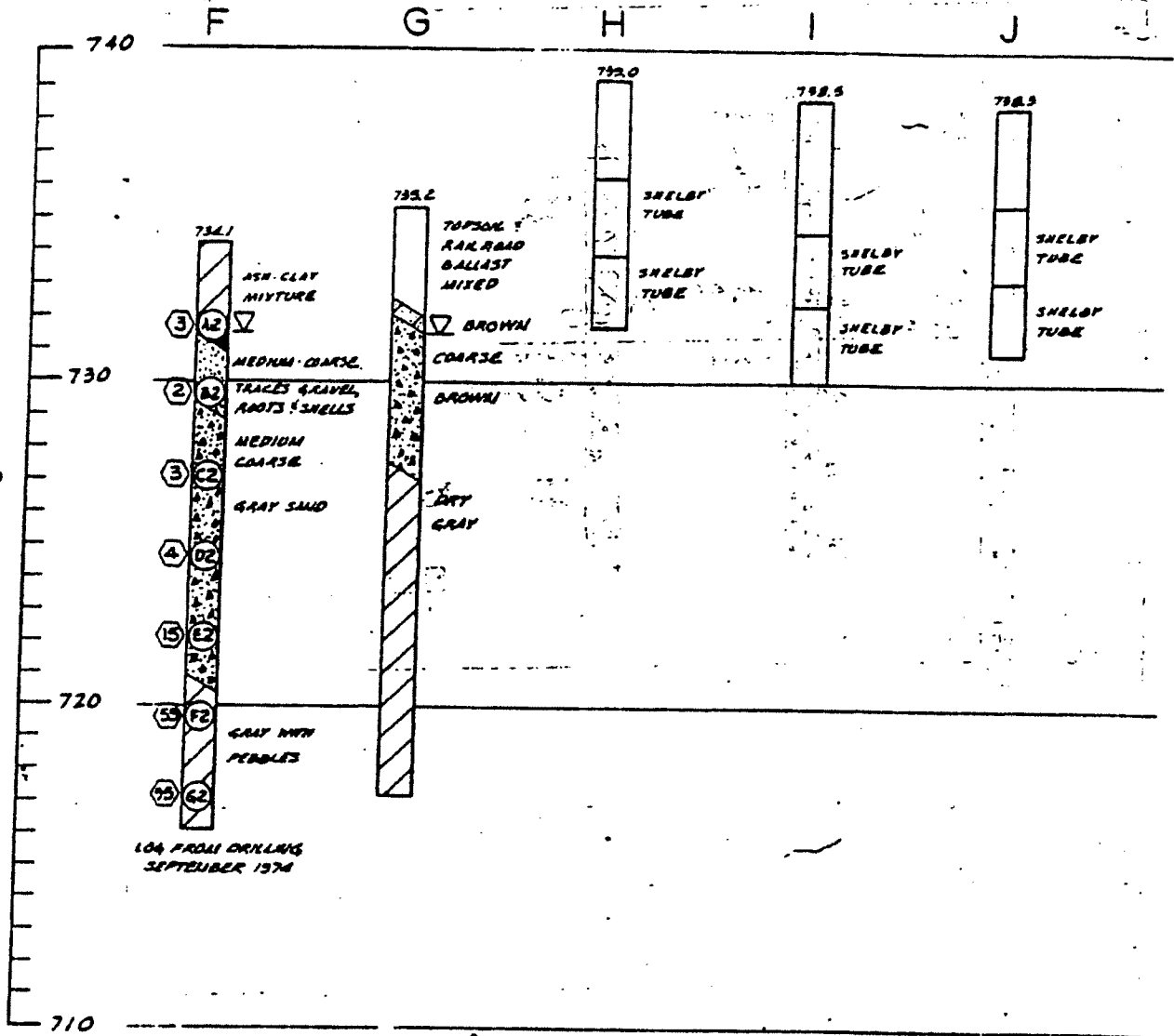


* NOTE:
AUGER BANK FROM 4 TO
8 FT. UNDER OWN WEIGHT

LEGEND:

- ORGANIC
- CLAY
- SAND
- GRAVEL
- OBSERVED WATER TABLE
- APPROXIMATE LOCATION OF BORING
- SAMPLE NUMBER
- NUMBER OF BLOWS FOR PENETRATION OF 1 FOOT OF 2" SPLIT TUBE SAMPLER - 140 LB HAMMER WITH 30" DROP

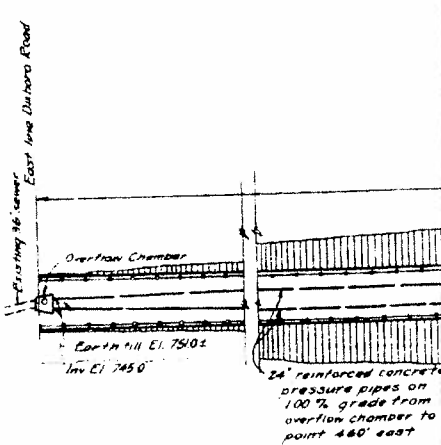
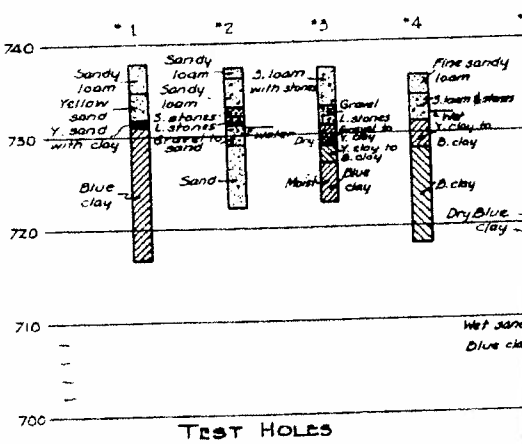
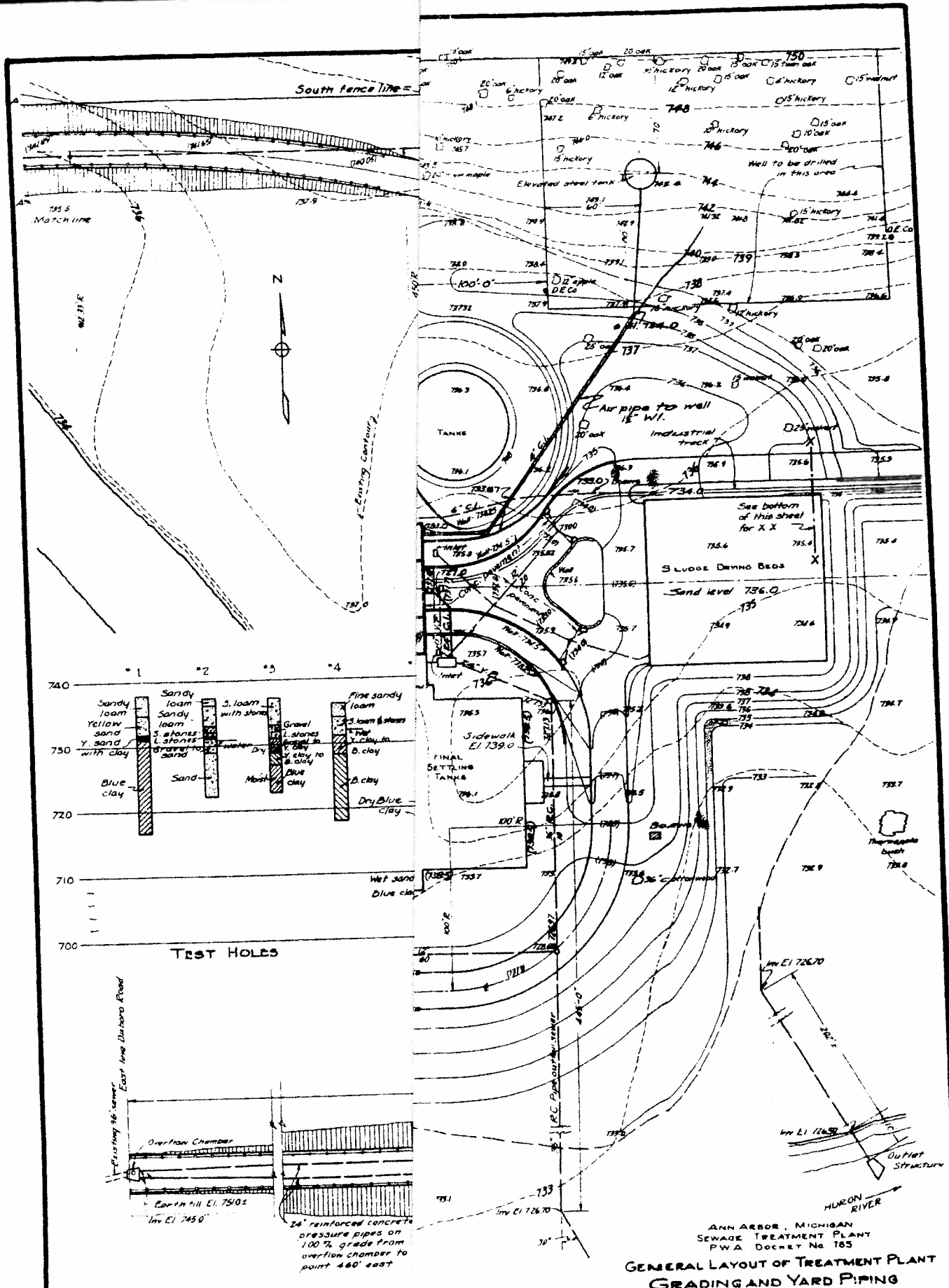
SECTION 36 TOWN 4 SOUTH RANGE 4 EAST ANN ARBOR TOWNSHIP WASHTENAW COUNTY, MICHIGAN	ATWELL-HICKS, INC. CIVIL ENGINEERS, SURVEYORS, PLANNERS ANN ARBOR 313-994-4000								
<p>DIMENSIONS IN FEET</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%;">DR: L.A.</td> <td style="width: 25%;">CH: F.J.J.</td> <td style="width: 50%;">DATE: 12-17-76</td> </tr> <tr> <td colspan="2">BOOK: _____</td> <td rowspan="2" style="font-size: 2em; text-align: center;">134-112</td> </tr> <tr> <td colspan="2">JOB: 31632</td> </tr> </table>	DR: L.A.	CH: F.J.J.	DATE: 12-17-76	BOOK: _____		134-112	JOB: 31632	
DR: L.A.	CH: F.J.J.	DATE: 12-17-76							
BOOK: _____		134-112							
JOB: 31632									



LEGEND:

- ORGANIC
- CLAY
- SAND
- GRAVEL
- OBSERVED WATER TABLE
- APPROXIMATE LOCATION OF BORING
- SAMPLE NUMBER
- NUMBER OF BLOWS FOR PENETRATION OF 1 FOOT OF 2" SPLIT TUBE SAMPLER - 140 LB HAMMER, WASH-Bottom-DROP

SECTION 36 TOWN 2 SOUTH-RANGE 6 EAST		ATWELL-HICKS, INC. CIVIL ENGINEERS, SURVEYORS, PLANNERS ANN ARBOR 313-984-1000		
ANN ARBOR TOWNSHIP WASHTENAW COUNTY, MICHIGAN				
<p>DIMENSIONS IN FEET</p>		DR: L.C.	CH: P.J.J.	DATE: 12-17-76
		BOOK: _____	134-112	
		JOB: 31632		

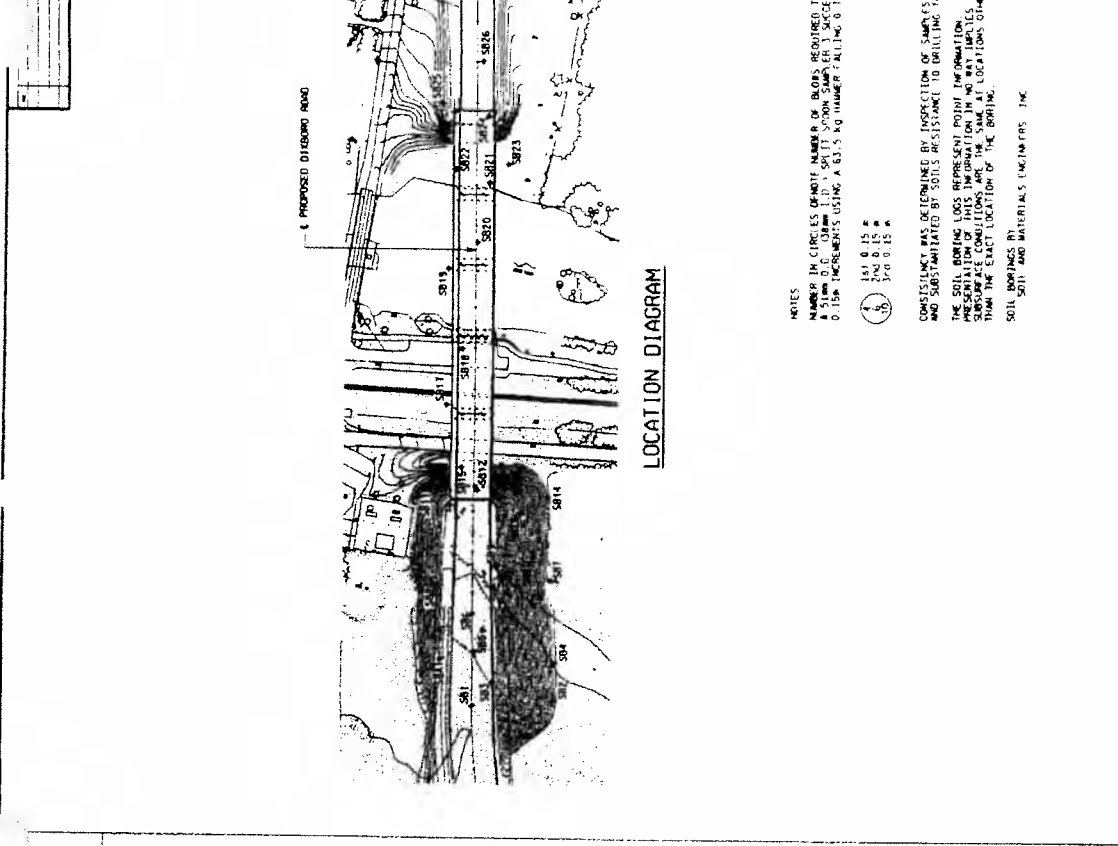


ANN ARBOR, MICHIGAN
 SEWAGE TREATMENT PLANT
 P.W.A. DOCKET No. 185
**GENERAL LAYOUT OF TREATMENT PLANT
 GRADING AND YARD PIPING**
 SCALE 1"=80'
 MAY 1935

DEWEY DEURY and McNAMEE
 VERA LEVIE, NORRIS and MAY
 CONSULTING ENGINEERS

Figure No. 35

DATE: 08/23/01	SKETCHED BY: JF	DESIGNED BY: JF	CHECKED BY: JF
131			
DIRBORO ROAD over THE HURON RIVER			
R01 OF R1-01-04 JK 4007A			
SOIL BORING DATA			



Boring SB1
Station 0+503
2' to left of Proposed 1

Driller reports 200 mm of Sandy Topsoil - Dark Brown

1 230.4
2 225.9
3 225.6
4 228.0
5 228.9
6 228.1
7 228.1
8 227.6
9 226.6
10 226.4

1.5 Clayey Sand Some Silt - Traces Gravel & Fragments - Brown Medium Dense (SP, CL)

1.5 Silt - Traces Sand & Gravel - Brown - Hard (CL, ML)

1.5 Fine to Medium Sand - Traces to Some Silt - Occasional Silty Clay Layer - Brown - Hard to Med. - Medium Dense (SP, CL)

3.5 Silty Clay - Traces to Some Sand & Gravel - Gray - Very Stiff to Hard (CL)

4.5 END OF BORING AT 4.57 M

GROUNDWATER LEVEL OBSERVATIONS:
1 Groundwater during Drilling - 2.44m
2 Groundwater after Drilling - 4.11m

DRILLING REMARKS:
Date Completed: 08/23/01

Boring SB2
Station 0+506
35' to Right of Proposed 1

Sedimentary Plect Trace Sand Black - Very Soft (SH)

1 775.9
2 775.9
3 725.1
4 724.1
5 724.1
6 724.1
7 721.6
8 721.6
9 722.5
10 722.5
11 722.1
12 721.9

1.5 Fine to Coarse Sand - Traces to Some Silt - Traces to Some Silt & Clay - Traces Gravel - Brown - Very Loose to Loose (SM)

1.5 Silty Clay - Traces to Some Sand - Traces Gravel - Occasional Silty Sand Layers & Silt Some Gray - Medium to Stiff (CL, SP, ML)

3.5 Fine to Coarse Sand - Traces to Some Silt - Clay & Gravel - Occasional Silty Clay Layers - Gray - Very Dense (SC, SM, CL)

4.5 END OF BORING AT 4.51 M

GROUNDWATER LEVEL OBSERVATIONS:
1 Groundwater during Drilling - 4.5m
2 Groundwater after Drilling - 1m

DRILLING REMARKS:
Date Completed: 08/23/01

NOTES

NUMBER IN CIRCLES DENOTE NUMBER OF BLOBS REQUIRED TO DRIVE TO THE POINT OF INTEREST FROM SURFACE. SUCCESSIVE 0.15m INCREMENTS USING A 63.5 mm DIAMETER TOLLING BAR.

1 151 0.15 #
2 240 0.15 #
3 390 0.15 #

CONSISTENCY WAS DETERMINED BY INSPECTION OF SAMPLES AND SUBSTITUTED BY SOILS RESISTANCE TO DRILLING TOOL.

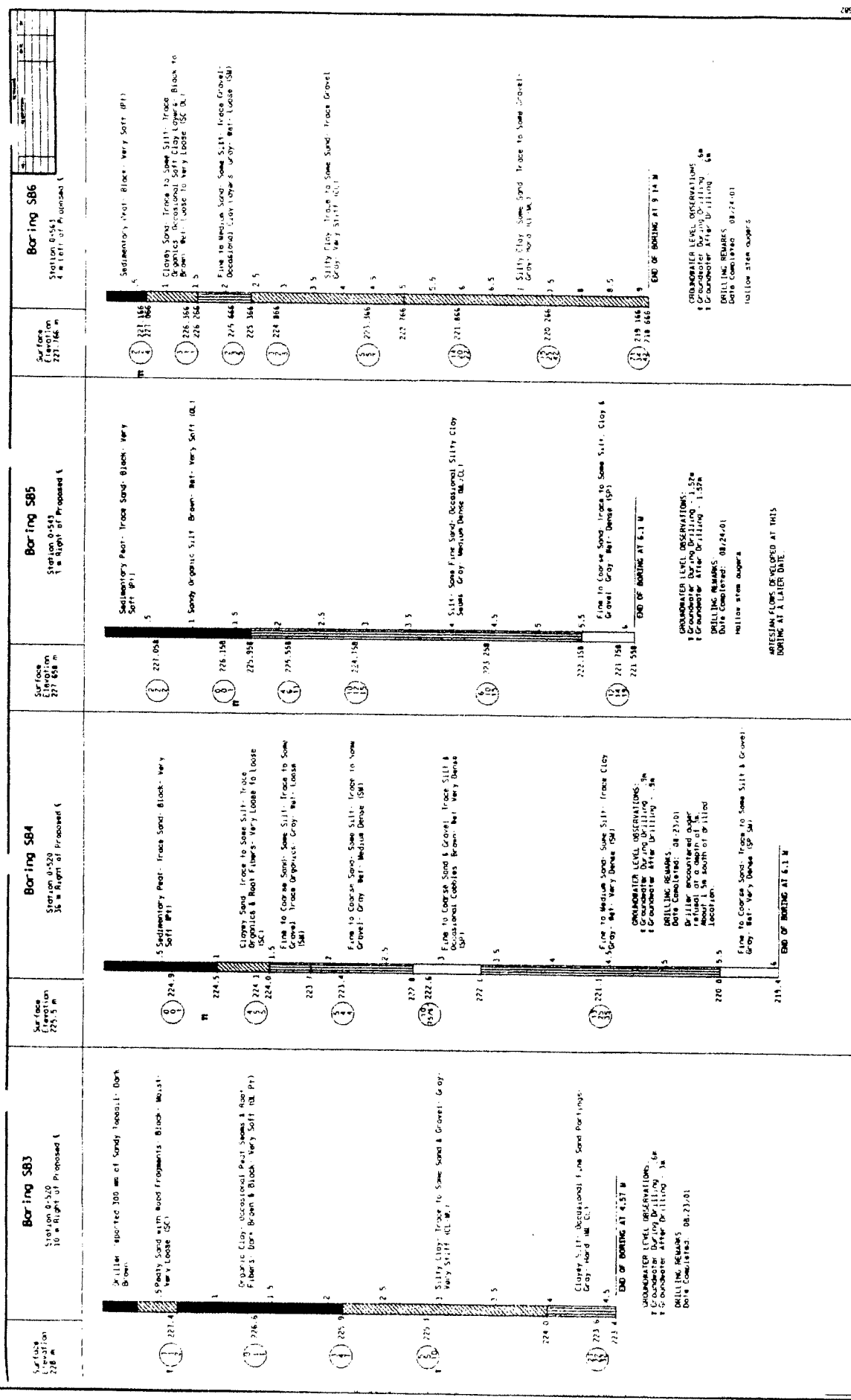
THE SOIL BORING LOGS REPRESENT POINT INFORMATION. SUBSTRATE CONDITIONS ARE THE SAME AT LOCATIONS OTHER THAN THE EXACT LOCATION OF THE BORING.

SOIL BORINGS BY
SOIL AND MATERIALS ENGINEERS, INC.

AVRES ASSOCIATES
Engineers / Surveyors
300 East Village Park Drive
Ann Arbor, MI 48106-1528
PH (734) 264-8911 FAX (734) 264-8433

CLIENT
Madison County Road Commission
200 W. Main St., P.O. Box 1528
Ann Arbor, Michigan 48106

DATE: 08/23/01
SKETCHED BY: JF
DESIGNED BY: JF
CHECKED BY: JF



AVRES ASSOCIATES
Engineers / Surveyors
300 East Village Point Drive
Madison, WI 53703
Phone: (608) 785-1111 Fax: (608) 785-1112

CLIENT
Madison County Road Commission
300 North Taylor, P.O. Box 1000
West Salem, Wisconsin 54601

PROJECT
DIXBORO ROAD OVER THE HURON RIVER
PRT OF B1-61-04 JN #0047A
SOIL BORING DATA

DATE: 08/24/01
SHEET: 132 OF 135
PROJECT: 08/24/01

DRILLING REMARKS:
1 Groundwater During Drilling - 1.52m
2 Groundwater After Drilling - 1.52m
Date Completed: 08/24/01
Hollow stem augers.

ARTESIAN FLOWS DEVELOPED AT THIS BORING AT A LATER DATE.

DATE	08/24/01
SHEET NO.	133
PROJECT NO.	08-27-01
DRILLING	
SOIL BORING	

Boring SB7
Station 0+51
1/4 Right of Proposed E

Surface Elevation 226.5 m

Surface Elevation 226.5 m

Boring SB8
Station 0+55
1/4 Left of Proposed E

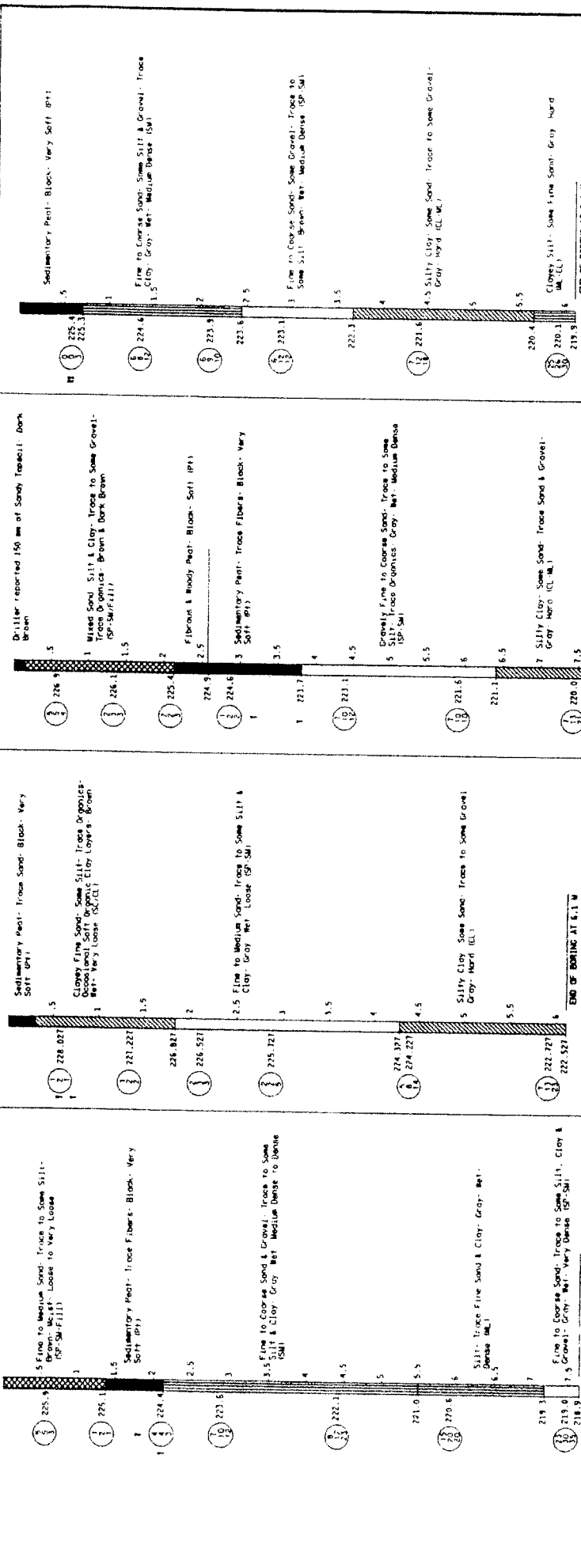
Surface Elevation 228.87 m

Surface Elevation 227.5 m

Boring SB9
Station 0+57
1/4 Right of Proposed E

Surface Elevation 226.0 m

Boring SB10
Station 0+58
2/4 Right of Proposed E

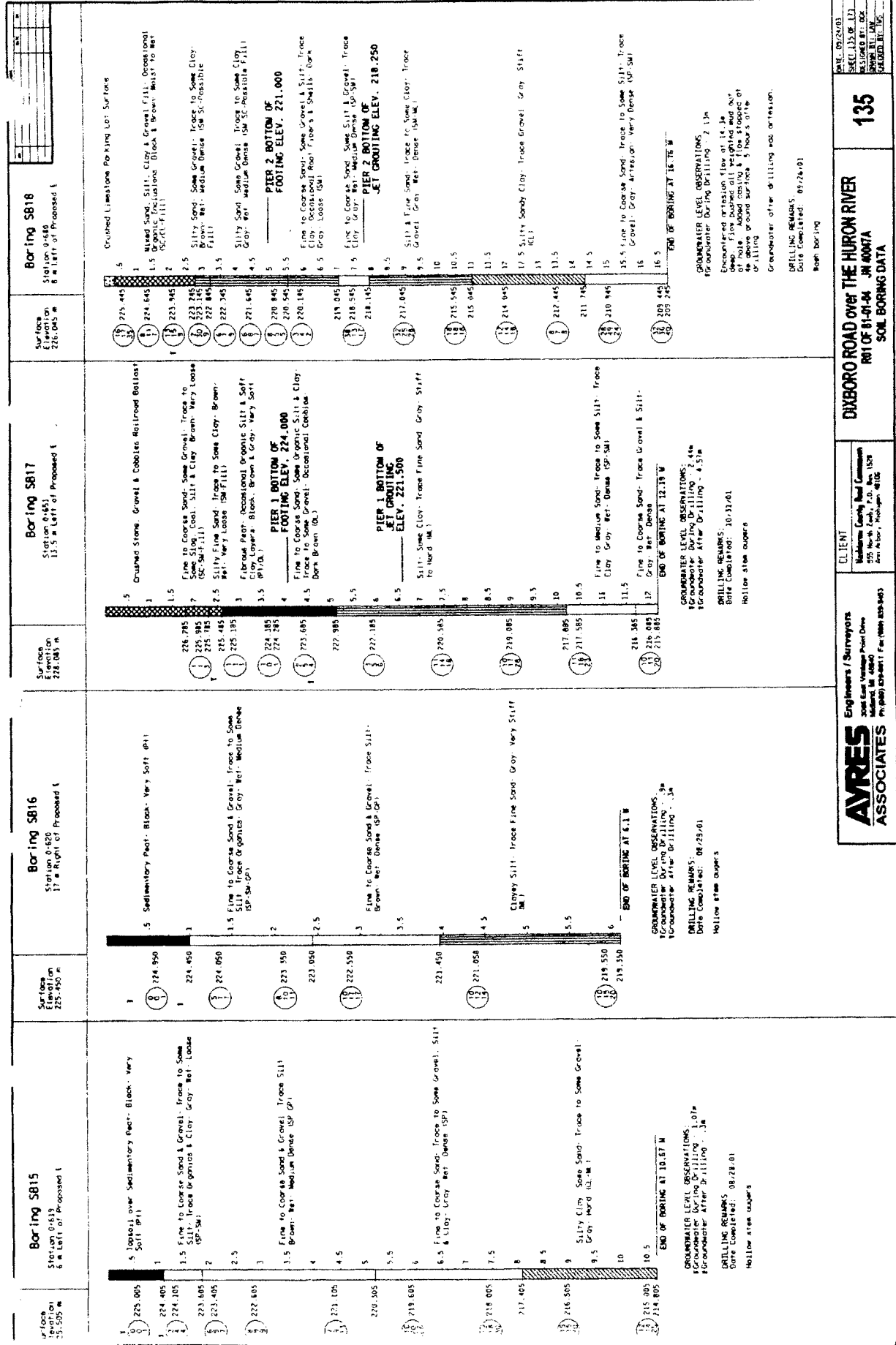


AVRES ASSOCIATES
Engineers / Surveyors
2000 East Vantage Point Drive
Midvale, UT 84040
Ph: (801) 581-1111 Fax: (801) 581-1112

CLIENT
Madison County Road Commission
200 North 2nd, P.O. Box 1570
New York, Michigan 48166

DUXBORO ROAD OVER THE HURON RIVER
RRI OF 01-07-04 JN 0007A
SOIL BORING DATA

DATE: 08/24/01
SHEET NO.: 133
PROJECT NO.: 08-27-01
DRILLING
SOIL BORING



AVRES ASSOCIATES
 Engineers / Surveyors
 2000 East Avenue, Suite 200
 Ann Arbor, Michigan 48106
 Phone: (734) 963-8400

CLIENT
 Michigan State Road Commission
 200 West Liberty, P.O. Box 1528
 Ann Arbor, Michigan 48106

PROJECT
 DIXBORO ROAD OVER THE HURON RIVER
 R01 OF 81-01-04, JN 4007A
 SOIL BORING DATA

DATE: 08/28/01
SCALE: 1:25.00 (1")
DESIGNED BY: DCR
CHECKED BY: DCR
DATE: 08/28/01

135

DIXBORO ROAD OVER THE HURON RIVER
 RBT OF 8-01-04 IN 48007A
 SOIL BORING DATA

CLIENT
 Michigan County Road Commission
 500 West 16th Street, P.O. Box 1528
 Ann Arbor, Michigan 48106

Engineers / Surveyors
 and Environmental Scientists
AVRES ASSOCIATES
 1500 East 10th Street, Suite 200
 Ann Arbor, Michigan 48106
 (734) 963-8811 Fax: (734) 963-8800

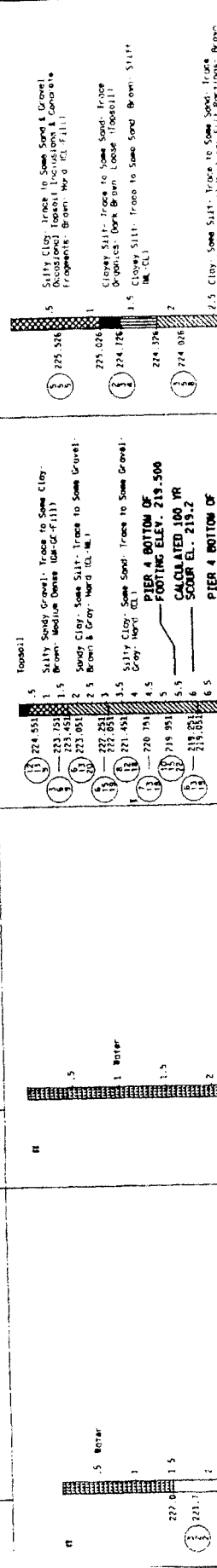
Station	Surface Elevation	Soil Description
SB19	227.5	Water
SB20	225.15	Sand & Gravel
SB21	223.05	Silty Sand
SB22	218.126	Silty Clay

Boring SB19
 Station 7+15
 21' N Left of Proposed I

Boring SB20
 Station 7+30
 2.5' N Left of Proposed I

Boring SB21
 Station 7+60
 8' N Right of Proposed I

Boring SB22
 Station 8+156
 5' Left of Proposed I



SOIL DESCRIPTIONS:
 1 Water
 1.5 Sand & Gravel
 2 Silty Sand
 2.5 Silty Clay
 3 Sand & Gravel
 3.5 CALCULATED 100 YR SCOUR ELEV. - 219.9
 4 PIER 3 BOTTOM OF FOOTING ELEV. - 219.500
 4.5
 5.5 Fine to Medium Sand - Trace to Some Silt - Gray
 6 Shell & Shells - Gray - Medium Dense (SM)
 6.5 PIER 3 BOTTOM OF JET CROUING ELEV. - 217.000
 7
 7.5 Fine to Medium Sand - Trace to Some Silt - Gray
 8 Fine to Coarse Sand - Some Silt & Clay - Trace to Some Gravel - Gray - Med. H.D. (CL)
 8.5 END OF BORING AT 8.5 M

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 2.5 Silty Clay
 3 Sand & Gravel
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 4 PIER 4 BOTTOM OF FOOTING ELEV. - 219.500
 4.5
 5.5 Silty Clay - Trace to Some Silt - Gray
 6 Shell & Shells - Gray - Medium Dense (SM)
 6.5 PIER 4 BOTTOM OF JET CROUING ELEV. - 217.500
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 7.5 Silty Clay - Trace to Some Silt - Gray
 8 Fine to Medium Sand - Trace to Some Silt - Gray
 8.5 END OF BORING AT 8.5 M

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GROUNDWATER LEVEL OBSERVATIONS:
 1 Groundwater During Drilling - 0.1a
 1 Groundwater After Drilling - 0.1a
 1 Jet & cut-head
 Date Completed: 11/28/01

GROUNDWATER LEVEL OBSERVATIONS:
 1 Groundwater During Drilling - 3.1a
 1 Encountered vibration flow of 10 in cpm
 1 & flow stabilized at about 2.15e above ground level of
 1 16 inch in hole to 2100' flow
 1 Groundwater after drilling was creation.
 Date Completed: 09/24/01
 Hollow steel cutters

GROUNDWATER LEVEL OBSERVATIONS:
 1 Groundwater During Drilling - 3.1a
 1 Encountered vibration flow of 10 in cpm
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 1 16 inch in hole to 2100' flow
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 Date Completed: 10/08/01
 Solid steel cutters

GROUNDWATER LEVEL OBSERVATIONS:
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 Date Completed: 09/24/01
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 Date Completed: 09/24/01
 Hollow steel cutters

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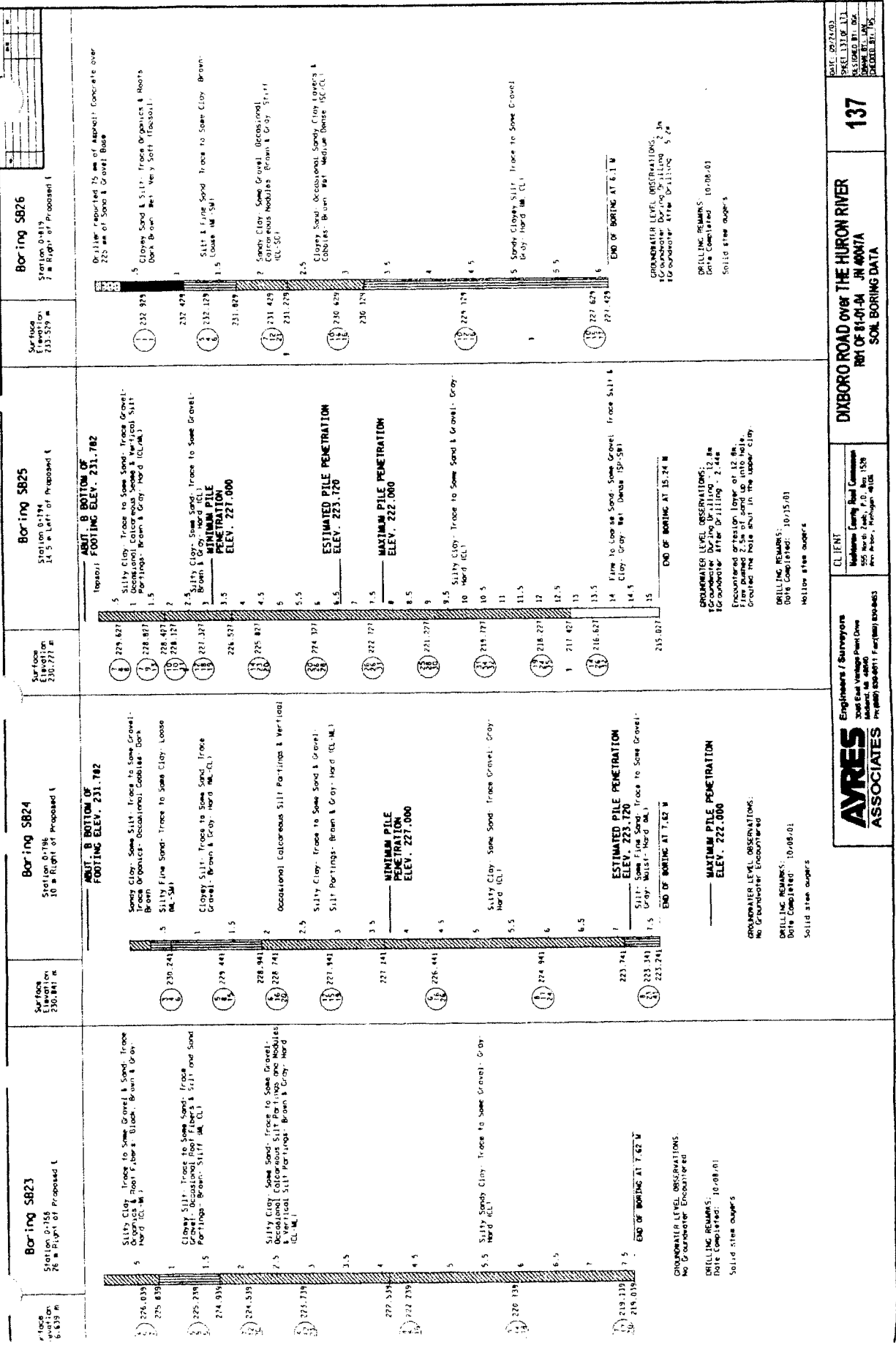
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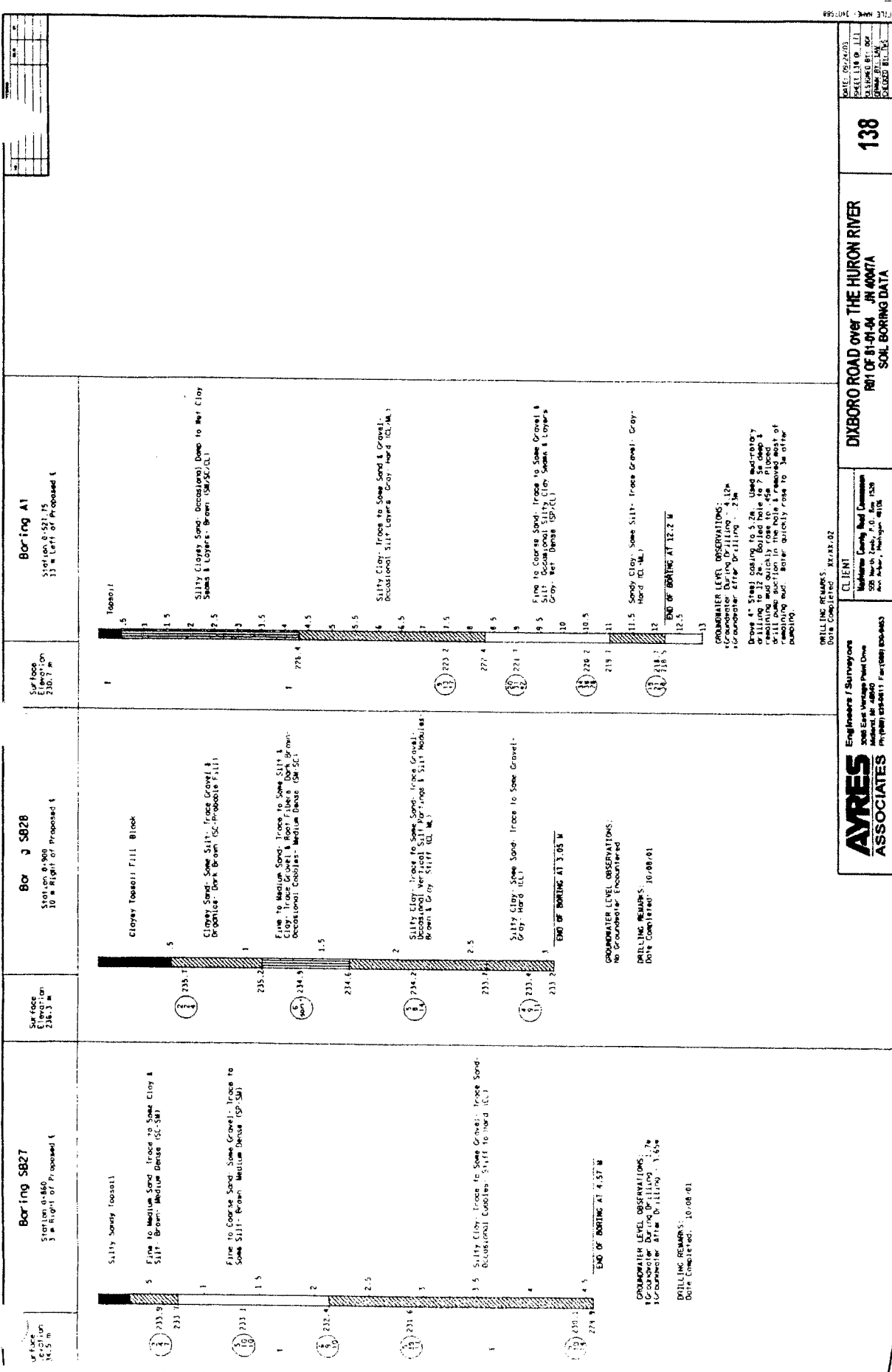
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 Hollow steel cutters



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DIXBORO ROAD OVER THE HURON RIVER
Rt 0+81-0+84 IN 400' STA
SOIL BORING DATA



AYRES ASSOCIATES
 Engineers / Surveyors
 500 North Lehigh P.O. Box 1528
 Allentown, PA 18106-1528
 Phone: 610-261-1111
 Fax: 610-261-1112

CLIENT
 DIXBORO ROAD over THE HURON RIVER
 R01 OF 81-01-04 IN 4007A
 SOIL BORING DATA

138

DATE: 09/24/03
 SHEET NO. OF 111
 DRAWN BY: JAC
 CHECKED BY: JAC
 SCALE: AS SHOWN

GEOLOGICAL SURVEY SAMPLE No.

WATER WELL RECORD
ACT 294 PA 1965

MICHIGAN DEPARTMENT
OF
PUBLIC HEALTH

1 LOCATION OF WELL			3 OWNER OF WELL:	
County <i>Wash.</i>	Twp. <i>Ann Arbor</i>	Fraction <i>SE 1/4 SE 1/4 NW 1/4</i>	Section No. <i>30</i>	Town <i>2 W.S.</i>
Distance And Direction from Road Intersections <i>at Huron River</i>			Range <i>6 E.</i>	
Street address & City of Well Location <i>49 S. Durbors Rd Ann Arbor</i>			Address <i>National Sentations Foundation 2355 Stadium Blvd Ann Arbor Mich</i>	
2 FORMATION			4 WELL DEPTH: (completed)	
			Thickness of STRATUM	Depth to BOTTOM of STRATUM
<i>Blue Clay</i>	<i>12</i>	<i>12</i>	Date of Completion <i>4-17-69</i>	
<i>Sand</i>	<i>2</i>	<i>15</i>	5 <input checked="" type="checkbox"/> Cable tool <input type="checkbox"/> Rotary <input type="checkbox"/> Driven <input type="checkbox"/> Dug	
<i>Blue Clay</i>	<i>79</i>	<i>94</i>	<input type="checkbox"/> Hollow rod <input type="checkbox"/> Jetted <input type="checkbox"/> Bored <input type="checkbox"/>	
<i>Gravel</i>	<i>2</i>	<i>96</i>	6 USE: <input type="checkbox"/> Domestic <input type="checkbox"/> Public Supply <input type="checkbox"/> Industry	
			7 CASING: Threaded <input type="checkbox"/> Welded <input checked="" type="checkbox"/>	
			Diam. <i>4 in.</i> to <i>9 1/2 ft.</i> Depth	
			8 SCREEN:	
			Type: <i>None</i> Dia.: _____	
			9 STATIC WATER LEVEL <i>18' plus about ground</i>	
			ft. below land surface	
			10 PUMPING LEVEL below land surface	
			<i>Flow</i> ft. after <i>1/2</i> hrs. pumping <i>100</i> g.p.m.	
			11 WATER QUALITY in Parts Per Million:	
			Iron (Fe) _____ Chlorides (Cl) _____	
			12 WELL HEAD COMPLETION: <input type="checkbox"/> In Approved Pit	
			<input checked="" type="checkbox"/> Pitless Adapter <input type="checkbox"/> 12" Above Grade	
			13 GROUTING:	
			Well Grouted? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	
			14 SANITARY:	
			Nearest Source of possible contamination _____ feet _____ Direction _____ Type _____	
			15 PUMP:	
			Manufacturer's Name <i>Deming</i>	
			Model Number <i>4786</i> HP <i>3/4</i>	
			Length of Drop Pipe <i>0</i> ft. capacity <i>22</i> G.P.M.	
			Type: <input type="checkbox"/> Submersible <input type="checkbox"/> _____	
			<input checked="" type="checkbox"/> Jet <input type="checkbox"/> Reciprocating	
16 Remarks, elevation, source of data, etc. <i>Pressure line over section from Pitless to pump. Replacements</i>			17 WATER WELL CONTRACTOR'S CERTIFICATION: This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief. <i>Cubley Drilling Co.</i> 524 REGISTERED BUSINESS NAME REGISTRATION NO. Address: <i>Dexter Mich</i> Signed: <i>J. G. Clark</i> Date: <i>6-1-69</i> AUTHORIZED REPRESENTATIVE	

067D 100M 6-66

