

CONTRACT DOCUMENTS

WPC Influent Structure and Battery A Grit Rehab

City of Flint
1101 S. Saginaw Street
Flint, MI 48502

March 2020



PREPARED BY:



555 South Saginaw Street
Suite 201
Flint, MI 48502



HUBBELL, ROTH & CLARK, INC
Consulting Engineers

555 Hulet Drive
P.O. Box 824
Bloomfield Hills, MI 48303

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Division 00
Procurement and Contracting Requirements



Sheldon A. Neeley
Mayor

CITY OF FLINT
Finance Department
Division of Purchases & Supplies

Joyce A. McClane
Purchasing Manager

INVITATION TO BID

OWNER:

THE CITY OF FLINT
DEPARTMENT OF PURCHASES AND SUPPLIES 1101 S. SAGINAW STREET, ROOM 203
FLINT, MI, 48502

Project Name: WPC Influent Structure and Battery A Grit Rehab

Proposal No.: 20000578

SCOPE OF WORK:

The City of Flint, Department of Purchases & Supplies, is soliciting sealed bids for providing:

Work shall include the bypassing of the Influent Structure, internal and external concrete repair of the Influent Structure, severing and plugging the existing interconnection between Grit Battery A and B, installation of sluice gates in the Influent Structure, installation of cured-in-place pipe and a flow meter on the Grit Battery A influent piping, construction of a new grit classifier building for Grit Battery A, as well as the removal and installation of new grit pumps, piping, valves, installation of new grit classifier, rehabilitation of existing grit tanks and associated electrical improvements, SCADA, concrete, demolition and sitework.

If your firm is interested in providing the requested services, please submit one(1) original, one(1) electronic copy, one (1) unbound copy of your bid in a sealed envelope to the City of Flint, Department of Purchases by **on a date and time to be announced, but not before May 21, 2020.** The outside of the envelope should clearly identify the project name and number, and the name and address of the Bidder. Please note: all bids received after 1:00 PM (EST) will not be considered. Faxed bids to the Purchasing Department will not be accepted. Bidding Documents shall meet requirements set forth in Specification Section 00 21 13, Instructions to Bidders.

A mandatory pre-bid meeting will be held **on a date and time to be announced, but not before May 7, 2020**, at the City of Flint's Water Pollution Control (WPC) Facility located at 4652 Beecher Road, Flint, Michigan 48532. This will be the only venue that potential contractors will be able to have a face-to-face conversation with both the Purchasing Department and WPC staff. This venue will also allow contractors to ask any questions concerning this Project.

Each bid proposal shall be submitted on the proposal forms provided and shall be accompanied by a certified check, cashier's check or bid bond, executed by the bidder and Surety Company, payable to Treasurer, City of Flint in the amount of five percent (5%) of the accompanying bid. Proposal Guarantee shall provide assurance that the bidder will, upon acceptance of the bid, execute the necessary Contract with the City. No bid may be withdrawn for one hundred twenty (120) days after scheduled closing time for receiving bids.

Proposals submitted by Bidders who have been debarred, suspended, or made ineligible by any Federal Agency will be rejected. The project is funded through the State Clean Water Revolving Loan program, requirements of the program are included in the Contract Documents.

Each bidder agrees to waive any claim it has or may have against the Owner, the Architect/Engineer, and their respective employees, arising out of or in connection with the administration, evaluation, or recommendation of any bid.

The City of Flint reserves the right to reject all bids and to waive irregularities in bidding.

All additional bid documents, requirements, addendums, specifications and plans/drawings (if utilized) are available on the Purchasing page of the City of Flint's web site at <https://www.cityofflint.com/finance/purchasing/> under "open bids" and the specific bid or proposal number assigned to this notice.

Anticipated Bid Submission Schedule:

Date Released/Bid Posted to City's Website:	Monday, April 27, 2020
Bid Advertisement:	Monday, April 27, 2020
Mandatory Pre-bid Meeting:	To Be Announced
Final Date for Questions:	To Be Announced
Final Addendum:	To Be Announced
Bid Due Date:	To Be Announced

The dates provided above are estimated dates only and may be subject to change.

Submit to City:	One (1) printed, signed, original proposal and addenda One (1) electronic copy of the proposal and addenda on flash drive One (1) printed, signed, copy of the proposal and addenda (unbound)
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Send to:	The City of Flint Department of Purchases and Supplies 1101 S. Saginaw Street, Room 203 Flint, MI 48502
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Effective immediately upon release of these Bidding Documents, and until notice of contract award, all official communications from proposers regarding the requirements of this Bid shall be directed to:

Joyce A. McClane
810-766-7340
jmcclane@cityofflint.com

The City, or designee, shall distribute all official changes, modifications, responses to questions or notices relating to the requirements of this Bid. Addendum to this Bid may be developed and shared with all Vendors. Any other information of any kind from any other source shall not be considered official, and proposers relying on other information do so at their own risk.

Sincerely,

Joyce A. McClane, Purchasing Manager

Section 00 2113

Instructions to Bidders

Part 1 General

1.01 Defined Terms

- A. Terms used in these Instructions to Bidders have the meanings assigned to them in the General Conditions.
 - 1. The term "Bidder" means one who submits a Bid directly to OWNER as distinct from a subbidder who submits a Bid to a Bidder.
 - 2. The term "Successful Bidder" means the lowest, qualified, responsible Bidder to whom OWNER makes an award.
 - 3. The term "OWNER" means City of Flint, a Municipal Corporation, and being a party of the first part of this Contract.
 - 4. The term "ENGINEER" means Wade Trim, Inc., 555 South Saginaw Street, Suite 201, Flint, Michigan 48502, or his duly authorized representative.
 - 5. The term "Issuing Office" means the office from which the Bidding Documents are to be issued and where the bidding procedures are to be administered.

1.02 Copies of Bidding Documents

- A. Complete sets of the Bidding Documents may be obtained from the Issuing Office stated in the Advertisement for Bid or Invitation to Bid.
- B. Complete sets of Bidding Documents shall be used in preparing Bids; neither OWNER nor ENGINEER assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.
- C. OWNER and ENGINEER, in making copies of Bidding Documents available on the above terms, do so only for the purpose of obtaining Bids for the Work and do not authorize or confer a license for any other use.

1.03 Scope of Work

- A. The scope and location of Work are set forth in Section 01 1100, Summary of Work.

1.04 Bidders Qualifications

- A. No Bid will be considered from any Bidder unless known to be skilled and regularly engaged in work of a character similar to that covered by the Contract Documents. In order to aid OWNER in determining the responsibility of any Bidder, the Bidder, within 48 hours after being requested in writing by OWNER to do so, shall furnish evidence, satisfactory to OWNER, of the Bidder's experience and familiarity with Work of the character specified, and his financial ability to properly prosecute the proposed Work to completion within the specified time. The evidence requested may include, but shall not be limited to, the following:
 - 1. The address and description of the Bidder's plant or permanent place of business.

2. The Bidder's performance records for all Work awarded to, or started by, him within the past three (3) years.
3. An itemized list of the Bidder's equipment available for use on the proposed Contract.
4. The Bidder's financial statement, including statement of ownership of equipment necessary to be used in executing Work under Contract.
5. Evidence that the Bidder is authorized to do business in the state in which the project is located, in case of a corporation organized under the laws of any other state; and,
6. Such additional information as will satisfy OWNER that the Bidder is adequately prepared to fulfill the Contract.

1.05 Pre-Bid Conference

- A. A mandatory Pre-Bid conference will be held Tuesday, April 14, 2020 at 10:00 A.M., at the City of Flint's Water Pollution Control (WPC) Facility, located at 4652 Beecher Road, Flint, MI 48532. Attendance at this meeting is required to submit a bid on the project.
- B. Representatives of OWNER and ENGINEER will be present to discuss the Project.
- C. Bidders are required to attend and participate in the conference.
- D. ENGINEER will transmit to all prospective Bidders a record of such Addenda as ENGINEER considers necessary in response to questions arising at the meeting. Oral statements made during the meeting may not be relied upon and will not be binding or legally effective.

1.06 Examination of Contract Documents and Site

- A. It is the responsibility of each Bidder before submitting a Bid, to:
 1. examine the Contract Documents thoroughly,
 2. visit the site to familiarize Bidder with local conditions that may in any manner affect cost, progress or performance of the Work,
 3. consider federal, state, and local Laws and Regulations that may affect cost, progress, performance, or furnishing of the Work; and
 4. study and carefully correlate Bidder's knowledge and observations with the Contract Documents and such other related data; and
 5. promptly notify ENGINEER in writing of all conflicts, errors, ambiguities or discrepancies which Bidder has discovered in or between Contract Documents and such related documents.
 6. purchase official Procurement Documents from ENGINEER in order to be included on the project Plan Holder List and be considered eligible for bidding.
- B. Reference is made to the Supplementary Conditions for the identification of those reports of investigations and tests of subsurface and latent physical conditions at the site or otherwise affecting cost, progress or performance of the Work which have been relied upon by ENGINEER in preparing the Contract Documents.

1. If such reports are not included as appendices to the Contract Documents, OWNER will make copies available to any Bidder requesting them. These reports are included for reference only and are not guaranteed as to accuracy or completeness, nor are they part of the Contract Documents.
 2. The Bidder may rely upon the general accuracy of the “technical data” contained in such reports but not upon other data, interpretations, opinions or information contained in such reports or otherwise relating to the subsurface conditions at the site, nor upon the completeness thereof for bidding or construction purposes.
 3. Before submitting each Bidder will, at the Bidder’s own expense, make such additional investigations and tests as the Bidder may deem necessary to determine Bid for performance of the Work in accordance with the time, price and other terms and conditions of the Contract Documents.
- C. On request, OWNER will provide each Bidder access to the site to conduct such investigations and tests as each Bidder deems necessary for submission of Bid. Bidder shall fill all holes and clean up and restore the site to its former conditions upon completion of such investigations and tests.
- D. The lands upon which the Work is to be performed, rights-of-way for access thereto and other lands designated for use by CONTRACTOR in performing the Work are identified in Section 01 1100, Summary of Work, or on the Plans.
- E. The locations of utilities as shown on the Plans are taken from sources believed to be reliable. Neither OWNER nor ENGINEER will be responsible for any omissions of, or variations from, the indicated location of existing utilities which may be encountered in the Work.
- F. The submission of a Bid will constitute an incontrovertible representation by the Bidder that he has complied with every requirement of this Article 1.04, that without exception the Bid is based upon performing and furnishing the Work required by the Contract Documents and applying the specific means, methods, techniques, sequences or procedures of construction (if any) that may be shown, indicated or required by the Contract Documents, that Bidder has given ENGINEER written notice of all conflicts, errors, ambiguities and discrepancies that Bidder has discovered in Contract Documents and the resolution by ENGINEER is acceptable to Bidder, and that the Contract Documents are sufficient in scope and detail to indicate and convey understanding of all terms and conditions for performing and furnishing the Work, and that the time stated in the Proposal is sufficient to complete the project.

1.07 Interpretations and Addenda

- A. Should any prospective bidder find discrepancies in, or omissions from the Plans, Specifications or other parts of the Contract Documents, he may submit a written request to the ENGINEER for an interpretation thereof. The person submitting the request will be held responsible for its prompt delivery at least seven (7) days prior to the date for opening of Bids. Questions received less than seven (7) days prior to the date for opening of bids will not be answered. Any interpretation of inquiry will be made by Addendum duly issued to all prospective bidders.
- B. Any change in or addition to the Contract Documents deemed necessary by the OWNER shall be made in the form of an Addendum issued to all prospective bidders who have taken out Contract Documents and all such Addenda shall become a part of the Contract Documents as though same were incorporated into same originally. Oral explanations and information do not constitute official notification and are not binding.

1.08 Bid Security

- A. Bid Security shall be made payable to OWNER, in an amount of five (5) percent of the Bidder's maximum Bid price and in a form as indicated in the Advertisement. Bid Bonds, if indicated as acceptable in the Advertisement, shall be issued on the form included in the Contract Documents by a Surety meeting the requirements of paragraph 5.01 of the General Conditions.
- B. The Bid Security of the Successful Bidder will be retained until such Bidder has executed the Agreement and furnished the required Contract Security, whereupon it will be returned; if the successful Bidder fails to execute and deliver the Agreement and furnish the required Contract Security within 15 days of the Notice of Award, OWNER may annul the Notice of Award and the Bid Security of that Bidder will be forfeited. The Bid Security of any Bidder whom OWNER believes to have a reasonable chance of receiving the award may be retained by OWNER until the earliest of the seventh day after the "Effective Date of Agreement" (which term is defined in the General Conditions) or the expiration of the hold period on the Bids. Bid Security of other Bidders will be returned within 14 days of the Bid opening, unless indicated otherwise in the Advertisement.

1.09 Contract Time

- A. The number of days within which, or the date by which, the Work is to be Substantially Completed, if applicable, and also completed and ready for final payment (the Contract Time) are set forth in the Proposal and will be included in the Agreement.

1.10 Substitute and "Or-Equal" Items

- A. The Contract, if awarded, will be on the basis of materials and equipment described in the Plans or specified in the Specifications without consideration of possible substitute or "or-equal" items. Whenever it is indicated in the Plans or specified in the Specifications that a substitute or an "or-equal" item of material or equipment may be furnished or used by CONTRACTOR if acceptable to ENGINEER, application for such acceptance will not be considered by ENGINEER until after the Effective Date of Agreement. In addition, in no case shall ENGINEER's denial of CONTRACTOR's application give rise to any claim for additional cost, it being understood by CONTRACTOR that acceptance of substitute or an "or equal" item of material is at the sole discretion of ENGINEER.

1.11 Receipt and Form of Bid

- A. Bids shall be submitted at the time and place indicated in the Advertisement for Bids and shall be included in an opaque sealed envelope, marked with the Project title and name and address of the Bidder and accompanied by the Bid Security and other required documents. If the Bid is sent through the mail or other delivery system, the sealed envelope shall be enclosed in a separate envelope with the notation "BID ENCLOSED" on the face thereof. Any Bid received after the scheduled time and place indicated in the Advertisement for Bids shall be returned unopened.
 - 1. OWNER invites bids on the Proposal and other form(s) attached hereto. Bids will be received at the time and place indicated in the Advertisement and thereupon will be publicly opened and read. An abstract of the amounts of the base bids and any major alternates will be made available after the opening of Bids.
 - 2. OWNER may consider as informal any Bid on which there is an alteration of, or departure from the Proposal Form attached hereto.

3. The complete set of Contract Documents must be used in preparing Bids: neither OWNER nor ENGINEER assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Contract Documents. In order to verify the completeness of the set of Contract Documents the Bidder used in preparing his Bid, OWNER may require the Bidder to submit the set of Contract Documents he used in preparing his Bid. The Bidder shall submit his Bid on the separate Proposal form included in these Contract Documents.
4. The Proposal shall be legibly prepared, with ink or typewriter, on the form included in these Contract Documents. All blank spaces in the proposal forms must be correctly filled in where indicated for each and every item for which a quantity is given. Proposals will be compared on basis of lump sum items, if any, and on product of the quantities of items listed at the respective unit prices bid.
5. Erasures or other changes in the Bids must be explained or noted over the signature of the Bidder.
6. Names must be typed or printed below the signature.
7. The quantities as shown in the Proposal are approximate only and will be used as a basis of comparison of Bids, and award of Contracts. Payment will be made on basis of actual quantities of Work performed in accordance with the Contract Documents. The Unit Prices bid, shall include such amounts as the Bidder deems proper for overhead, profit, taxes, General Conditions and such other incidentals as noted in the Contract Documents.
8. The Bid shall contain an acknowledgment of receipt of all Addenda, the numbers of which shall be filled in on the Proposal Form.
9. The Legal Status of Bidder Form contained in the Contract Documents must be submitted with each Proposal and must clearly state the legal position of a Bidder. In the case of a corporation, the home address, name and title of all officers must be given. In the case of a partnership, show names and home addresses of all partners. If an individual, so state. Any individual bid not signed by the individual must have attached, thereto, a power of attorney evidencing authority to sign.
10. Other documents to be attached to the Proposal and made a condition thereof are identified in the Proposal. The same individual signing the Proposal shall sign these other documents.

1.12 Modifications and Withdrawal of Bids

- A. Bids may be modified or withdrawn by an appropriate document duly executed (in the manner that a Bid must be executed) and delivered to the place where Bids are to be submitted at any time prior to the opening of Bids. If, within 24 hours after Bids are opened, any Bidder files a duly signed written notice with OWNER and promptly thereafter demonstrates to the reasonable satisfaction of OWNER that there was a material and substantial mistake in the preparation of his Bid, that Bidder may withdraw his Bid and the Bid Security will be returned. Thereafter, at the sole option of OWNER, that Bidder will be disqualified from further Bidding on the Work to be provided under the Contract Documents.

1.13 Award of Contract

- A. OWNER reserves the right to reject any and all Bids for any reason, to waive any and all informalities not involving price, time, or changes in the Work and to negotiate contract terms with the Successful Bidder, and the right to disregard all nonconforming, non-responsive, unbalanced, or conditional Bids. Discrepancies between words and figures will be resolved in favor of words. Discrepancies in the multiplication of units of work and unit prices, will be resolved in favor of unit price. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum.
- B. In evaluating Bids, OWNER shall consider the qualifications of the Bidders, whether or not the Bids comply with the prescribed requirements, and such alternates, unit prices and other data if requested in the Bid forms. It is OWNER's intent to accept alternates (if any are accepted) in the order in which they are listed in the Bid form but OWNER may accept them in any order or combination.
- C. Subject to the approval of OWNER, the Contract will be awarded to the lowest responsive and responsible Bidder. Responsibility of Bidder will be determined on basis of past performance and Work of similar character, equipment and labor available to do the Work and financial status. The Contract shall be considered to have been awarded after the approval of OWNER has been duly obtained and a formal Notice of Award duly served on the successful Bidder by OWNER. The Contract shall not be binding upon OWNER until the Agreement has been duly executed by the Bidder and the duly authorized officials of OWNER.
- D. If the Contract is to be awarded, OWNER will give the successful Bidder a Notice of Award within 180 days after the day of the Bid opening, unless such other time is specified in the Advertisement for Bids.

1.14 Signing of Agreement

- A. Within 15 days after OWNER gives a Notice of Award to the successful Bidder, CONTRACTOR shall sign and deliver the specified number of counterparts of the Agreement to OWNER with all other Contract Documents attached. Within 10 days thereafter, OWNER will deliver 2 fully signed counterparts to CONTRACTOR. ENGINEER will identify, date or correct those portions of the Contract Documents not fully signed, dated or executed by OWNER and CONTRACTOR and such identification, dating or correction shall be binding on all parties.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

End of Section

Section 00 2213

Supplementary Instructions to Bidders

Part 1 General

1.01 American Iron and Steel Requirements

- A. CONTRACTOR acknowledges to and for the benefit of the City of Flint ("Purchaser") and the Michigan Department of Environmental Quality (the "State") that it understands the goods and services under this Agreement are being funded with monies made available by the State Revolving Fund and/or the Drinking Water Revolving Fund and such law contains provisions commonly known as "American Iron and Steel (AIS);" that requires all iron and steel products used in the project be produced in the United States ("AIS Requirements") including iron and steel provided by CONTRACTOR pursuant to this Agreement.
- B. CONTRACTOR hereby represents and warrants to and for the benefit of the Purchaser and the State that:
 - 1. CONTRACTOR has reviewed and understands the AIS Requirements:
 - 2. all iron and steel used in the project will be and/or have been produced in the United States in a manner that complies with the AIS Requirements, unless a waiver of the requirements is approved or the State made the determination in writing that the AIS Requirements do not apply to the project, and
 - 3. CONTRACTOR will provide any further verified information, certification or assurance of compliance with this paragraph, or information necessary to support a waiver of the AIS requirements, as may be requested by the Purchaser.
- C. Notwithstanding any other provision of this Agreement, any failure to comply with this paragraph by CONTRACTOR shall permit the Purchaser or State to recover as damages against CONTRACTOR any loss, expense or cost (including without limitation attorney's fees) incurred by the Purchaser or State resulting from any such failure (including without limitation any impairment or loss of funding, whether in whole or in part, from the State or any damages owed to the State by the Purchaser).
- D. While CONTRACTOR has no direct contractual privity with the State, as a lender to the Purchaser for the funding of its project, the Purchaser and CONTRACTOR agree that the State is a third-party beneficiary and neither this paragraph (nor any other provision of this Agreement necessary to give these paragraphs force or effect) shall be amended or waived without the prior written consent of the State.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

End of Section

Section 00 4243 Proposal

City of Flint
1101 S. Saginaw Street
Flint, MI 48502

Re: WPC Influent Structure and Battery A Grit Rehab

The undersigned Bidder proposes and agrees, if this Proposal is accepted, to enter into an Agreement with the City of Flint (OWNER) in the form included in the Contract Documents to complete all Work as specified or indicated in the Contract Documents for the Contract Price and within the Contract Time indicated in this Bid and in accordance with the Contract Documents.

In submitting this Proposal, Bidder represents, as more fully set forth in the Agreement, that;

- a) Bidder has examined copies of all Contract Documents which he understands and accepts as sufficient for the purpose, including any and all Addenda officially issued, the receipt of which is hereby acknowledged.

Addendum No.	Date of Release	Signature
_____	_____	_____
_____	_____	_____
_____	_____	_____

- b) Bidder has examined the surface and subsurface conditions where the Work is to be performed, the legal requirements and local conditions affecting cost, progress, furnishing or performance of the Work and has made such independent investigations as Bidder deems necessary.
- c) This Bid is genuine and not made in the interest of or on behalf of any undisclosed person, firm or corporation and is not submitted in conformity with any Agreement or rules of any group, association, organization or corporation; Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid; Bidder has not solicited or induced any person, firm or a corporation to refrain from bidding; and Bidder has not sought by collusion to obtain for himself any advantage over any other Bidder or over OWNER.

The Bidder agrees to complete the Work, in accordance with the Contract Documents, for the following Contract Price:

Base Bid

Item	Description	Quantity	Unit	Unit Price	Amount
1.	Mobilization	1	LSUM	\$ _____	\$ _____
2.	Bypass Pumping	1	LSUM	\$ _____	\$ _____
3.	Influent Structure Structural Rehabilitation	1	LSUM	\$ _____	\$ _____
4.	Influent Structure Brick Replacement	320	EACH	\$ _____	\$ _____
5.	Influent Structure Brick Repointing	590	LFT	\$ _____	\$ _____
6.	Battery A Grit Improvements & Grit Handling Building	1	LSUM	\$ _____	\$ _____
7.	SCADA Programming Allowance	1	LSUM	\$ <u>10,000.00</u>	\$ <u>10,000.00</u>
8.	Owner-Controlled Contingency Allowance	1	LSUM	\$ <u>100,000.00</u>	\$ <u>100,000.00</u>

TOTAL CONTRACT PRICE FOR BASE BID:

_____ \$ _____
(In Words) (Numeric)

Additive Alternate

Item	Description	Quantity	Unit	Unit Price	Amount
3A.	Battery B Grit Piping Rehabilitation	1	LSUM	\$ _____	\$ _____

TOTAL CONTRACT PRICE FOR ADDITIVE ALTERNATE:

_____ \$ _____
(In Words) (Numeric)

All specified cash allowances are included in the price(s) set forth above and have been computed in accordance with Paragraph 11.02 of the General Conditions and Section 01 2100, Allowances.

Proposed Subcontractors. Bidder proposes to utilize the services of the major subcontractors listed below for this Work.

Mechanical _____

Electrical _____

Instrumentation/SCADA _____

Other _____

The undersigned, as Bidder, hereby certifies that he or a qualified designated person in his employ has examined the Contract Documents provided by OWNER for bidding purposes. Further, the undersigned certifies that he or his qualified employee has reviewed the Bidder's proposed construction methods and finds them compatible with the conditions and from the information provided for Bidding.

The undersigned, as Bidder, shall complete the Work under any job circumstances or field conditions present and/or ascertainable prior to bidding. In addition, he shall also complete the Work under whatever conditions he may create by his own sequence of construction, construction methods, or other conditions he may create, at no additional cost to OWNER.

The undersigned, as Bidder, declares that he has familiarized himself with the location of the proposed Work and the conditions under which it must be constructed. Also, that he has carefully examined the Plans, the Specifications, and the Contract Documents, which he understands and accepts as sufficient for the purpose and agrees that he will Contract with OWNER to furnish all labor, material, tools, and equipment necessary to do all Work specified and prescribed for the completion of the Project.

The undersigned agrees, if awarded Contract, to sign the Agreement and submit satisfactory bonds and certificates of insurance coverage and other evidence of insurance required by the Contract Documents within 15 days after the date of OWNER'S Notice of Award.

The undersigned agrees that time is of the essence and, if awarded Contract, that the Work will be Substantially Completed within 300 days of the issuance of the Notice to Proceed and completed within 365 days of the issuance of said notice.

Liquidated damages, as specified in the General Conditions, Supplementary Conditions and Agreement, shall also apply to the above Substantial Completion date.

Engineering and inspection costs incurred after the above final completion date shall be paid by CONTRACTOR to OWNER as specified in the Conditions of the Contract and Agreement.

Proposals may not be withdrawn for a period of one hundred eighty (180) days after bid opening.

The following documents are attached to and made a condition of this Proposal:

a) Required Bid security in the form checked below:

☐ Certified Check ☐ Cashier's Check ☐ Money Order ☐ Bid Bond

b) Legal Status of Bidder.

c) Bidder's Name: _____

By: _____
(Signature) *(Printed Name)*

Address: _____

Phone No.: _____ Fax No.: _____

Email: _____

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned, _____
as Principal, hereinafter called the Principal, and _____
a corporation duly organized under the laws of the State of _____, and duly authorized to
transact business in the state of Michigan, as Surety, hereinafter called the Surety, are held and firmly
bound unto the City of Flint, hereinafter called OWNER, in the sum of _____
_____ Dollars (\$ _____)
for the payment of which sum well and truly to be made, the said Principal and the said Surety, bind
ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by
these presents.

WHEREAS, the Principal has submitted a Bid for _____

NOW, THEREFORE, if OWNER shall accept the Bid of the Principal and the Principal shall enter into a Contract with OWNER in accordance with the terms of such Bid, and give such Bond or Bonds as may be specified in the Contract Documents with good and sufficient surety for the faithful performance of such Contract and for the prompt payment of labor and material furnished in the prosecution thereof, or in the event of the failure of the Principal to enter such Contract and give such Bond or Bonds, if the Principal shall pay to OWNER the difference not-to-exceed the penalty hereof between the amount specified in said Bid and such larger amount for which OWNER may in good faith contract with another party to perform the Work covered by said Bid, then this obligation shall be null and void, otherwise to remain in full force and effect.

Signed and Sealed this _____ day of _____, 20____.

(Witness)

(Principal)

(Title)

(Witness)

(Surety)

(Title)

Section 00 4345 Legal Status of Bidder

This Proposal is submitted in the name of:

(Print) _____

The undersigned hereby designates below his business address to which all notices, directions or other communications may be served or mailed:

Street _____

City _____

State _____ Zip Code _____

The undersigned hereby declares that he has legal status checked below:

- ☐ SOLE PROPRIETOR
- ☐ SOLE PROPRIETOR DOING BUSINESS UNDER AN ASSUMED NAME
- ☐ CO-PARTNERSHIP
- The Assumed Name of the Co-Partnership is registered in the County of _____, Michigan
- ☐ CORPORATION INCORPORATED UNDER THE LAWS OF THE STATE OF _____ The Corporation is
- ☐ authorized to conduct business in the State of Michigan
- ☐ not now authorized to conduct business in the State of Michigan
- ☐ possess all required licenses for the work being bid
- ☐ limited liability corporation

The name, titles, and home addresses of all persons who are officers or partners in the organization are as follows:

NAME AND TITLE

HOME ADDRESS

Signed this _____ day of _____, 20____.

By (Signature)

Printed Name of Signer

Title

Section 00 4546.13
Certification Regarding Debarment, Suspension and
Other Responsibility Matters

The prospective participant certifies, to the best of its knowledge and belief, that it and its principals:

- (1) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in transactions under federal non-procurement programs by any federal department or agency;
- (2) Have not, within the three-year period preceding the proposal, had one or more public transactions (federal, state, or local) terminated for cause or default; and
- (3) Are not presently indicted or otherwise criminally or civilly charged by a government entity (federal, state, or local) and have not, within the three-year period preceding the proposal, been convicted of or had a civil judgment rendered against it:
 - (a) For the commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public transaction (federal, state, or local) or a procurement contract under such a public transaction;
 - (b) For the violation of federal or state antitrust statutes, including those proscribing prices fixing between competitors, the allocation of customers between competitors, or bid rigging; or
 - (c) For the commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property.

I understand that a false statement on this certification may be grounds for the rejection of this proposal or the termination of the award. In addition, under 18 U.S.C. §1001, a false statement may result in a fine of up to \$10,000 or imprisonment for up to five years, or both.

Name and Title of Authorized Representative

Name of Participant Agency or Firm

Signature of Authorized Representative

Date

☐ I am unable to certify to the above statement. Attached is my explanation.

Section 00 4539.13

Disadvantaged Business Enterprise (DBE)

Part 1 General

1.01 Summary

- A. Prime contractors bidding on this project must follow, document, and maintain documentation of their Good Faith Efforts, as listed below, to ensure that Disadvantaged Business Enterprises (DBEs) have the opportunity to participate in the project by increasing DBE awareness of procurement efforts and outreach. Bidders must make the following Good Faith Efforts for any work that will be subcontracted.
1. Ensure DBEs are made aware of contracting opportunities to the fullest extent practicable through outreach and recruitment activities. Place DBEs on solicitation lists and solicit DBEs whenever they are potential sources.
 2. Make information on forthcoming opportunities available to DBEs. Arrange time-frames for contracts and establish delivery schedules, where the requirements permit, in a way that encourages and facilitates participation by DBEs in the competitive process. Whenever possible, post solicitation for bids or proposals for a minimum of 30 calendar days before the bid or proposal closing date. The DBEs should be given a minimum of 5 days to respond to the posting.
 3. Consider in the contracting process whether firms competing for large contracts can be subcontracted with DBEs. Divide total requirements, when economically feasible, into smaller tasks or quantities to permit maximum participation by DBEs in the competitive process.
 4. Encourage contracting with a consortium of DBEs when a contract is too large for one DBE firm to handle individually.
 5. Use the services and assistance of the Small Business Administration and the Minority Business Development Agency of the U.S. Department of Commerce.
- B. Subsequent to compliance with the Good Faith Efforts, the following conditions also apply under the DBE requirements. Completed Good Faith Efforts Worksheets (Attachment 1), along with the required supporting documentation outlined in the instructions, must be submitted with your bid proposal. EPA form 6100-2 must also be provided at the pre-bid meeting. A copy of this form is available on the Forms and Guidance page of the Revolving Loan website.
1. The prime contractor must pay its subcontractor for work that has been satisfactorily completed no more than 30 days from the prime contractor's receipt of payment from the owner.
 2. The prime contractor must notify the owner in writing prior to the termination of any DBE subcontractor for convenience by the prime contractor and employ the Good Faith Efforts if soliciting a replacement contractor.
- If a DBE contractor fails to complete work under the subcontract for any reason, the prime contractor must employ the Good Faith Efforts if soliciting a replacement contractor.
3. The prime contractor must employ the Good Faith Efforts.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

End of Section

See next page for Attachment 1, Instructions, Frequently Asked Questions and DBE Subcontractor Participation Form.

Attachment 1

**Michigan Department of Environmental Quality
Office of Drinking Water and Municipal Assistance- Revolving Loan Section
Disadvantaged Business Enterprise (DBE) Utilization
State Revolving Fund/Drinking Water Revolving Fund
GOOD FAITH EFFORTS WORKSHEET**

Bidder: _____

Subcontract Area of Work (one per worksheet: _____)

Outreach Goal: Solicit a minimum of three (3) DBEs via email/letter/fax. it is recommended that various sources be used to locate the minimum number of DBEs. The Michigan Department of Transportation (MDOT) website and www.sam.gov registries may be two resources used to find a minimum of three DBEs.

List the DBEs contacted for the above area of work and complete the following information for each DBE.

Company Name	Type of Contact	Date of Contact	Price Quote Received	Accepted/ Rejected	Please Explain if Rejected
				<input type="checkbox"/> A <input type="checkbox"/> R	
				<input type="checkbox"/> A <input type="checkbox"/> R	
				<input type="checkbox"/> A <input type="checkbox"/> R	
				<input type="checkbox"/> A <input type="checkbox"/> R	
				<input type="checkbox"/> A <input type="checkbox"/> R	
				<input type="checkbox"/> A <input type="checkbox"/> R	

Explanation for Not Achieving a Minimum of Three Contacts; you may include a printout of the MDOT and www.sam.gov search results (attach extra sheets if necessary):

MITA DBE Posting Date (if applicable): _____
(attach a copy of the DBE advertisement)

Other Efforts (attach extra sheets if necessary): _____

Please include the completed worksheet and supporting documentation with the bid proposal.

Authorized under Parts 43 & 54 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

www.michigan.gov/deq

**Michigan Department of Environmental Quality
Office of Drinking Water and Municipal Assistance- Revolving Loan Section
Disadvantaged Business Enterprise (DBE) Utilization
State Revolving Fund/Drinking Water Revolving Fund
GOOD FAITH EFFORTS WORKSHEET**

Instructions to Bidders for the Completion of the Good Faith Efforts Worksheet

1. Separate worksheets must be provided for each area of work to be subcontracted out. This includes both major and minor subcontracts.
2. A minimum of three (3) DBEs must be contacted by a verifiable means of communication such as e-mail, lever, or fax for each area of work to be subcontracted out. Copies of the solicitation letters/e-mails and fax confirmation sheets must be provided with the worksheet.
3. if less than three (3) DBEs exist statewide for the area of work, then provide documentation that other DBE resources were consulted. This may include the MOOT and www.sam.gov registries and an advertisement in a publication. A printout of the website searched (conducted prior to the end of the bid period) must be submitted.
4. Posting solicitations for quotes/proposals from DBEs on the MITA website (www.mitadbe.com) is highly recommended to facilitate participation in the competitive process whenever possible. The solicitation needs to identify the project and the areas of work to be subcontracted out. A copy of the MITA DBE advertisement must be submitted with the Good Faith Efforts worksheet, if used, or a printout of the resulting quotes posted to the MITA website can be submitted with this form as supporting documentation.
5. If the area of work is so specialized that no DBEs exist, then an explanation is required to support that conclusion, including the documentation required in No. 3 above.
6. The date of the DBE contact must be identified, as it is important to document that the DBE solicitation was made during the bid period and that sufficient time was given for the DBE to return a quote.
7. Each DBE firm's price quote must be identified if one was received or N A entered on the worksheet if a quote was not received. Copies of all quotes must be submitted with the worksheet.
8. If a quote was received, indicate if it was accepted or rejected. Justification for not accepting a quote and not using the DBE subcontractor must be provided.
9. Under Other Efforts, please indicate additional steps you have taken to obtain DBE contractors and provide the appropriate supporting documentation such as:
 - Follow-up e-mails, faxes, or letters.
 - Copies of announcements/postings in newspapers, trade publications, or minority media that target DBE firms.

Rev. 3-2015

Authorized under Parts 43 & 54 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

Disadvantaged Business Enterprise (DBE) Requirements Frequently Asked Questions Regarding Contractor Compliance

Q: What is the Good Faith Efforts Worksheet form and how is it to be completed?

A: This form captures efforts by the prime contractor to solicit DBEs for each area of work type that will be subcontracted out. A separate Good Faith Efforts Worksheet must be provided by the prime contractor for each area of work type to be subcontracted out. There are specific instructions that accompany this form that prescribe minimum efforts which bidders must make in order to be in compliance with the DBE requirements.

Q: Can non-certified DBEs be used?

A: While non-certified DBEs can be used, only DBEs, MBEs, and WBEs that are certified by EPA, SBA, or MOOT (or by tribal, state and local governments, as long as their standards for certification meet or exceed the standards in EPA policy) can be counted toward the fair share goal. Proof of certification by one of these recognized and approved agencies should be sought from each DBE.

Q: How does a DBE get certified?

A: Applications for certification under MOOT can be found at <http://mdotjboss.state.mi.us/UCP/LearnHowServ1et>

Applications for certification under EPA can be found on EPA's Small Business Programs website at http://www.epa.gov/osbp/dbe_firm.htm under Certification Forms.

Q: If a bidder follows the MOOT DBE requirements, will the bidder be in compliance with the SRF/DWRF DBE requirements?

A: No. Federally funded highway projects utilize DBE goals, which require that a certain percentage of work be performed by DBE subcontractors. For SRF/DWRF projects there is no financial goal. However, there is a solicitation effort goal. Bidders must use Good Faith Efforts for each and every area of work to be subcontracted out to obtain DBEs. The bidders are not required to use DBEs if the quotes are higher than non-DBE subcontractors. There is no required DBE participation percentage contract goal for the SRF/DWRF. However, if the SRF/DWRF project is part of a joint project with MOOT, the project can be excluded from SRF/DWRF DBE requirements (i.e., the Good Faith Efforts Worksheet is not required) as it would be difficult to comply with both programs' requirements.

Q: Must the Good Faith Efforts Worksheet and supporting documentation be turned in with the bid proposals?

A: Yes. This is a requirement to document that the contractor has complied with the DBE requirements and the Good Faith Efforts. These compliance efforts must be done during the bidding phase and not after-the-fact. It is highly recommended that the need for these efforts and the submittal of the forms with the bid proposals be emphasized at the pre-bid meetings. Failure to show that the Good Faith Efforts were complied with during the bidding process can lead to a prime contractor being found non-responsive.

Q: Does EPA form 6100-2 need to be provided at the pre-bid meeting?

A: Yes. The form must be made available at the pre-bid meeting.

Q: What kinds of documentation should a contractor provide to document solicitation efforts?

A: Documentation can include fax confirmation sheets, copies of solicitation letters/e-mails, printouts of online solicitations, printouts of online search results, affidavits of publication in newspapers, etc.

Q: How much time will compliance with the Good Faith Efforts require in terms of structuring an adequate bidding period?

A: Due to the extent of the efforts required, a minimum of 30 calendar days is recommended between bid posting and bid opening to ensure adequate time for contractors to locate certified DBEs and solicit quotes.

Q: How does a contractor locate certified DBEs?

A: The Michigan Department of Transportation has a directory of all Michigan certified entities located at <http://mdotjboss.state.mi.us/UCP/>. Additionally, the federal System for Award Management (SAM) is another place to search and can be found at www.sam.gov. SAM contains information from the former Central Contractor Registration (CCR) database.

Q: If the bidder does not intend to subcontract any work, what forms, if any, must be provided with the bid proposal?

A: The bidder should complete the Good Faith Efforts Worksheet with a notation that no subcontracting will be done. However, if the bidder is awarded the contract and then decides to subcontract work at any point, then the Good Faith Efforts must be made to solicit DBEs.

Q: In the perfect world, the Good Faith Efforts Worksheet is required to be turned in with the proposal. What if no forms are turned in with the bid proposal or forms are blank or incomplete? Should this be cause to determine that the bidder is non-responsive?

A: While the Good Faith Efforts Worksheet is important, it is more critical to confirm that the contractor complied with the DBE requirements prior to bid opening. The owner should contact the bidder as soon as deficiencies are noted for a determination/documentation of efforts taken to comply with the DBE requirements. Immediate submittal of the completed forms will be acceptable provided the Good Faith Efforts were made and it is just a matter of transferring information to the forms.

**Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Participation Form**

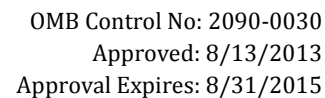
An EPA Financial Assistance Agreement Recipient must require its prime contractors to provide this form to its DBE subcontractors. This form gives a DBE¹ subcontractor² the opportunity to describe work received and/or report any concerns regarding the EPA-funded project (e.g., in areas such as termination by prime contractor, late payments, etc.). The DBE subcontractor can, as an option, complete and submit this form to the EPA DBE Coordinator at any time during the project period of performance.

Subcontractor Name		Project Name	
Bid/ Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact	
Address			
Telephone No.		Email Address	
Prime Contractor Name		Issuing/Funding Entity:	

Contract Item Number	Description of Work Received from the Prime Contractor Involving Construction, Services , Equipment or Supplies	Amount Received by Prime Contractor

¹ A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.205 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

² Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an EPA award of financial assistance.



Please use the space below to report any concerns regarding the above EPA-funded project:

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Subcontractor Signature	Print Name
Title	Date

The public reporting and recordkeeping burden for this collection of information is estimated to average three (3) hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

Section 00 5100 Notice of Award

To: _____

Date: _____, 20____

Attention: _____

Project: WPCF Influent Structure and Battery A Grit Chamber Rehabilitation

Pursuant to the provisions of Article 1.11 of the Instructions to Bidders, you are hereby notified that the City of Flint (OWNER) during a _____ Meeting held on _____, _____, 20____, has directed the acceptance of your Bid for the above-referenced Project in the amount of _____ Dollars (\$_____). This project shall consist of the bypassing of the Influent Structure, internal and external concrete repair of the Influent Structure, severing and plugging the existing interconnection between Grit Battery A and B, installation of sluice gates in the Influent Structure, installation of cured-in-place pipe and a flow meter on the Grit Battery A influent piping, construction of a new grit classifier building for Grit Battery A, as well as the removal and installation of new grit pumps, piping, valves, installation of new grit classifier, rehabilitation of existing grit tanks and associated electrical improvements, SCADA, concrete, demolition and site work as delineated in your Bid submitted to the City of Flint on _____, _____, 20____.

Please comply with the following conditions within 15 days of the date of this Notice of Award; that is by _____, _____, 20____.

1. Deliver to the ENGINEER 6 fully executed counterparts of the Agreement including all the Contract Documents.
2. Deliver with the executed Agreement the Contract Security (Bonds), on the form included in the Contract Documents, as specified in the General Conditions (Article 5).
3. Deliver with the executed Agreement the Insurance Certificates (and other evidence of insurance) as specified in the General Conditions (Article 5).
4. Please do not date Agreement and Contract Security (Bonds) as these will be dated by OWNER when executed by OWNER.

It is important to comply with these conditions and time limits as failure to comply with these conditions within the time specified will entitle OWNER to consider your bid abandoned, to annul this Notice of Award and to declare your Bid Security forfeited.

Within 10 days after you comply with those conditions, OWNER will return to you 2 fully signed counterparts of the Agreement with the Contract Documents attached.

In accordance with paragraph 2.05 of the General Conditions, please submit to ENGINEER the required schedules prior to the scheduling of a Pre-Construction Meeting.

Copy to ENGINEER:
Wade Trim, Inc.
555 S. Saginaw Street, Suite 201
Flint, MI 48502

(OWNER)

By: _____
(Authorized Signature)

Section 00 5200 Agreement

This Agreement, made and entered into this ____ day of ____ in the year 20____ by and between the City of Flint, hereinafter called OWNER, and _____ hereinafter called CONTRACTOR, in consideration of the mutual covenants hereinafter sent forth, agree as follows:

ARTICLE 1. WORK

CONTRACTOR shall complete all Work as specified or indicated in the Contract Documents. The Work is generally described as follows:

Bypassing of the Influent Structure, internal and external concrete repair of the Influent Structure, severing and plugging the existing interconnection between Grit Battery A and B, installation of sluice gates in the Influent Structure, installation of cured-in-place pipe and a flow meter on the Grit Battery A influent piping, Construction of a new grit classifier building for Grit Battery A, as well as the removal and installation of new grit pumps, piping, valves, installation of new grit classifier, rehabilitation of existing grit tanks and associated electrical improvements, SCADA, concrete, demolition and sitework.

ARTICLE 2. CONTRACT TIME

- 2.1 The Work will be substantially completed within 300 days of the issuance of the Notice to Proceed, and completed and ready for final payment in accordance with Paragraph 14.11 of the General Conditions within 365 days of said notice.
- 2.2 Engineering and inspection costs incurred after the specified final completion date shall be paid by the CONTRACTOR to the OWNER prior to final payment authorization. Charges shall be made at such times and in such amounts as the ENGINEER shall invoice the OWNER, provided however said charges shall be in accordance with the ENGINEER's current rate schedule at the time the costs are incurred. The costs of ENGINEER incurred after the specified final completion date shall be deducted from the CONTRACTOR's progress payments.
- 2.3 Liquidated Damages. OWNER and CONTRACTOR recognize that time is of the essence of this Agreement and that OWNER will suffer financial loss if the Work is not Substantially Complete within the time specified in Article 2.1 above, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. They also recognize the delays, expense and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by OWNER if the Work is not Substantially Complete on time. Accordingly, instead of requiring any such proof, OWNER and CONTRACTOR agree that as liquidated damages for delay (but not as penalty) CONTRACTOR shall pay OWNER **One Thousand Dollars (\$1,000.00)** for each day that expires after the time specified in Article 2.1 for Substantial Completion until the Work is Substantially Complete. Liquidated damages charged shall be deducted from the CONTRACTOR's progress payment.

ARTICLE 3. CONTRACT PRICE

- 3.1 OWNER shall pay CONTRACTOR as provided in the attached Proposal for performance of the Work in accordance with the Contract Documents.

ARTICLE 4. PAYMENT PROCEDURES

Progress payments and retainage under this Contract are governed by the provisions of PA 1980, No. 524 (MCLA 125.1561 et seq.). That Act is incorporated herein by reference and made a part of this Contract. Without excluding any provisions of the Act from this Contract, but in order to comply therewith and summarize certain provisions, the following shall apply:

- 4.1 The person representing CONTRACTOR who will submit written requests for progress payments shall be: _____
- 4.2 The person representing OWNER to whom requests for progress payments are to be submitted shall be: _____
- 4.3 CONTRACTOR's representative, listed above, shall submit Applications for Payment on the form provided in the Contract Documents in accordance with Article 14 of the General Conditions. Applications for Payment will be processed as provided in the General Conditions.

ARTICLE 5. CONTRACTOR'S REPRESENTATIONS

In order to induce OWNER to enter into this Agreement, CONTRACTOR makes the following representations:

- 5.1 CONTRACTOR has considered the nature and extent of the Contract Documents, Work, locality, and all local conditions and federal, state and local laws, and regulations that may affect cost, progress, performance, or furnishing of the Work.
- 5.2 CONTRACTOR has studied carefully all reports of investigations and tests of subsurface and latent physical conditions at the site or otherwise affecting cost, progress or performance of the Work which were relied upon in the preparation of the Plans and Specifications and which have been identified in the Supplementary Conditions.
- 5.3 CONTRACTOR has made or caused to be made examinations, investigations and tests and studies of such reports and related data in addition to those referred to in Article 5.2 as he deems necessary for the performance of the Work at the Contract Price, within the Contract Time and in accordance with the other terms and conditions of the Contract Documents; and no additional examinations, investigations, tests, reports or similar data are or will be required by CONTRACTOR for such purposes.
- 5.4 CONTRACTOR has correlated the results of all such observations, examinations, investigations, tests, reports and data with the terms and conditions of the Contract Documents.
- 5.5 CONTRACTOR has given ENGINEER written notice of all conflicts, errors or discrepancies that he has discovered in the Contract documents and the written resolution thereof by ENGINEER is acceptable to CONTRACTOR.

ARTICLE 6. CONTRACT DOCUMENTS

The Contract Documents which comprise the entire Contract between OWNER and CONTRACTOR are attached to this Agreement, made a part hereof and consists of the following:

- 6.1 Procurement Requirements (including Advertisement for Bids, Instructions to Bidders, Proposal, Legal Status of Bidder, and other documents listed in the Table of Contents thereof);
- 6.2 This Agreement;

- 6.3 Performance and other Bonds;
- 6.4 Notice of Award;
- 6.5 Notice to Proceed (if issued);
- 6.6 Conditions of the Contract (including General Conditions and Supplementary Conditions, if any);
- 6.7 Specifications contained within Division 01 through 49 of the Contract Documents dated March 2020;
- 6.8 Plans consisting of sheets dated March 2020 and is inclusive with each sheet bearing the following general title: WPCF Influent Structure and Battery A Grit Chamber Rehabilitation;
- 6.9 Addenda numbers ____ to ____, inclusive;
- 6.10 Documentation submitted by CONTRACTOR prior to Notice of Award; and
- 6.11 Any modification, including Change Orders, duly delivered after execution of Agreement.

ARTICLE 7. MISCELLANEOUS

- 7.1 Terms used in this Agreement which are defined in Article 1 of the General Conditions shall have the meanings indicated in the General Conditions.
- 7.2 No assignment by a party hereto of any rights under or interests in the Contract Documents will be binding on any other party without the written consent of the party sought to be bound; and specifically but without limitation, monies that may become due and monies that are due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.
- 7.3 OWNER and CONTRACTOR each binds himself, his partners, successors, assigns and legal representatives to the other party hereto, his partners, successors, assigns and legal representatives in respect to all covenants, agreements and obligations contained in the Contract Documents.
- 7.4 Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon OWNER and CONTRACTOR, who agree that the Contract Documents shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

IN WITNESS WHEREOF, the parties hereto have signed this Agreement in 6 counterparts. Three (3) counterparts each have been delivered to OWNER, 2 counterparts each have been delivered to CONTRACTOR, and 1 counterpart has been delivered to ENGINEER. All portions of the Contract Documents have been signed or identified by OWNER and CONTRACTOR.

This Agreement will be effective on _____, _____, 20____.

OWNER _____

CONTRACTOR _____

By _____

By _____

Attest _____

Attest _____

Address for giving notices

Address for giving notices

License No. _____

Agent for service of process: _____

**Section 00 5500
Notice to Proceed**

To: _____

Date: _____, 20____

Attention: _____

Project: WPCF influent Structure and Battery A Grit Chamber Rehabilitation

Please note that the Contract Time under the above Contract will commence to run on _____, _____, 20____. Within 10 days of this date you are to start performing the Work. The time to achieve Substantial Completion and Final Completion are set forth in the Agreement: they are 300 days and 365 days, respectively.

In accordance with Paragraph 2.05 of the General Conditions, please submit to ENGINEER the required schedules prior to the scheduling of a Pre-Construction Meeting.

Also, in accordance with Paragraph 2.05 of the General Conditions, please request a Pre-Construction Meeting from ENGINEER prior to delivery of any materials or start of any construction. A minimum of 3 full working days notice is required to set up the Pre-Construction Meeting. Also, please notify ENGINEER 3 full working days in advance of any staking requirements or other activity on the Project.

Work at the site must be started by _____, _____, 20____.

Copy to ENGINEER:

Wade Trim, Inc.
555 S. Saginaw Street, Suite 201
Flint, MI 48502

(OWNER)

By: _____
(Authorized Signature)

Section 00 6000 Project Forms

Part 1 General

1.01 Available Forms

- A. The following Project Forms are available for use by OWNER, CONTRACTOR and/or ENGINEER for this project and are located in Exhibit 1 of the Contract Documents:

1. Certificate of Substantial Completion
2. Change Order
3. Change Proposal
4. Construction Change Requisition / Work Change Directive
5. Field Order
6. Non-Compliance Notice / Order to Remove Defective Work
7. Open Items List
8. Punch List Items
9. Request for Final Inspection
10. Request for Information
11. Substitution Request Form
12. Warranty Data Sheet
13. City of Flint Material Disposal Form

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

End of Section

**Section 00 6112
Performance Bond**

Bond No. _____

KNOW ALL MEN BY THESE PRESENTS, that we, _____, a corporation organized and existing under the laws of the State of _____, and duly authorized to transact business in the State of Michigan, hereinafter called the "Principal," and _____, a corporation organized and existing under the laws of the State of _____, and duly authorized to transact business in the State of Michigan, as Surety, hereinafter called "Surety", are held and firmly bound unto _____, as Oblige, and hereinafter called "Obligee," in the just and full sum of _____ Dollars (\$_____) lawful money of the United States of America, to be paid to the said Oblige, to which payment well and truly to be made, we bind ourselves, our heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITIONS OF THIS OBLIGATION is such that, WHEREAS, the above Principal has entered into a contract with the said Oblige, dated the _____ day of _____, _____, for

_____.

Herein referred to and made a part hereof as fully and to the same extent as if the same were entirely written herein, and

WHEREAS, it was one of the conditions of the award of the said Oblige, pursuant to which said contract was entered into, that these presents should be executed.

AND THE SAID SURETY, for value received, hereby stipulates and agrees that no change, extension of time, or any other forbearance, alteration or addition to the terms of the contract or to the work to be performed thereunder or the Contract Documents accompanying the same shall in anywise affect its obligations on this bond, and it does hereby waive notice of any such change, extension of time, or any other forbearance, alteration or addition to the terms of the contract or to the Work or to the Contract Documents.

NOW, THEREFORE, if the above Principal shall in all respects comply with the terms and conditions of said contract, and his (their or its) obligations thereunder, including the Contract Documents therein referred to and made a part thereof, and such alteration as may be made in such contract or Contract Documents, as herein or therein provided for, then this obligation shall be void; otherwise, this bond and obligation shall be and remain in full force and effect.

Signed and sealed this _____ day of _____.

Signed, sealed and delivered in the presence of:

Witness for CONTRACTOR

(Principal)

(Title)

By _____

Witness for Surety

(Surety)

(Title)

Attorney-In-Fact (Seal)

By _____

Address

Address of Surety

City Zip Code

City Zip Code

Telephone

Telephone

Section 00 6113
Labor and Material Payment Bond

Bond No. _____

KNOW ALL MEN BY THESE PRESENTS, That we, _____, a corporation organized and existing under the laws of the State of _____, and duly authorized to transact business in the State of Michigan, hereinafter called the "Principal," and _____, a corporation organized and existing under the laws of the State of _____, and duly authorized to transact business in the State of Michigan, as Surety, hereinafter called "Surety", are held and firmly bound unto _____, as Obligee, and hereinafter called "Obligee," in the just and full sum of _____ Dollars (\$ _____), lawful money of the United States of America, to be paid to the said Obligee, to which payment well and truly to be made, we bind ourselves, our heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITIONS OF THIS OBLIGATION is such that, WHEREAS, the above Principal has entered into a contract with the said Obligee, dated the _____ day of _____, _____, for

which contract is herein referred to and made a part hereof as fully and to the same extent as if the same were entirely written herein, and

WHEREAS, it was one of the conditions of the award of the said Obligee, pursuant to which said contract was entered into, that these presents should be executed.

AND WHEREAS, this Bond is given in compliance with and subject to the provisions of Act No. 213 of the Public Acts of Michigan for the year 1963, as amended, including all notices, time limitation provisions and other requirements set forth therein, which are incorporated herein by reference.

AND THE SAID SURETY, for value received, hereby stipulates and agrees that no change, extension of time, or any other forbearance, alteration or addition to the terms of the contract or to the Work to be performed thereunder or the Contract Documents accompanying the same shall in anywise affect its obligations on this bond, and it does hereby waive notice of any such change, extension of time, or any other forbearance, alteration or addition to the terms of the contract or to the Work or to the Contract Documents.

NOW, THEREFORE, the condition of this obligation is such that if all claimants as defined in Act No. 213 of the Public Acts of Michigan for the year 1963, as amended, are timely paid for all labor and material used or reasonably required for use in the performance of the contract, then this obligation shall be void; otherwise, it shall remain in full force and effect.

Signed and sealed this _____ day of _____.

Signed, sealed and delivered in the presence of:

Witness for CONTRACTOR

(Principal)

(Title)

By _____

Witness for Surety

(Surety)

(Title)

By _____

Attorney-In-Fact (Seal)

Address

Address of Surety

City Zip Code

City Zip Code

Telephone

Telephone

Section 00 6119
Maintenance & Guarantee Bond

Bond No. _____

KNOW ALL MEN BY THESE PRESENTS, That we, _____, a corporation organized and existing under the laws of the State of _____, and duly authorized to transact business in the State of Michigan, hereinafter called the "Principal," and _____, a corporation organized and existing under the laws of the State of _____, and duly authorized to transact business in the State of Michigan, as Surety, hereinafter called "Surety", are held and firmly bound unto _____, as Obligee, and hereinafter called "Obligee," in the just and full sum of _____ (\$ _____) Dollars lawful money of the United States of America, to be paid to the said Obligee, to which payment well and truly to be made, we bind ourselves, our heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITIONS OF THIS OBLIGATION is such that, WHEREAS, the above Principal has entered into a contract with the said Obligee, dated the _____ day of _____, _____, for

Herein referred to and made a part hereof as fully and to the same extent as if the same were entirely written herein, and

NOW THEREFORE, the condition of this obligation is that under the Contract Documents, CONTRACTOR has agreed with OWNER that for a period of one (1) year from the date of payment of the Final Estimate, CONTRACTOR shall keep in good order and repair any defect in the Work, either by CONTRACTOR or its Subcontractors that may develop or be discovered during said one (1) year period due to improper materials, defective equipment, workmanship, or arrangements and any other work affected in making good such imperfections. CONTRACTOR also agreed to promptly make such repairs as directed by OWNER for replacement of the Work, without cost to OWNER, except for such parts of the Work as may have been disturbed without the consent of CONTRACTOR after the final acceptance of the Work, whenever directed so to do by notice from OWNER. If CONTRACTOR fails to make such repair within one (1) week from the date of receipt of such notice, then OWNER shall have the right to purchase such materials and employ such labor and equipment as may be necessary for the purpose and to undertake, to and make such repairs and charge the cost thereof to CONTRACTOR and receive payment for the same promptly from the CONTRACTOR or Surety.

If any repair is necessary to be immediately made to protect persons or property then, and in such event, OWNER may, but shall not be required to, take immediate steps to repair such defects without notice to CONTRACTOR. In such event, OWNER shall not be required to obtain the lowest bid for the performance of the Work or any part thereof, and all sums actually paid therefore shall be charged to the CONTRACTOR or Surety. In this regard, the judgment of OWNER shall be final and conclusive. CONTRACTOR shall, for a period of one (1) year from the date of payment of the Final Estimate, keep the Work in good order and repair, except for such parts of the Work which may have been disturbed without the consent of CONTRACTOR after the final acceptance of the Work. CONTRACTOR shall further, whenever notice is given as hereinbefore specified, promptly proceed to make the repair as in said notice directed or reimburse OWNER for any cost incurred by OWNER in making such repairs.

If CONTRACTOR or Surety shall fail to do as hereinbefore specified, they shall jointly and severally indemnify, defend, and hold harmless OWNER from and against all and any losses, costs, suits, and actions for damages of every kind and description brought or claimed against OWNER for or on account of any injury or damage to persons or property received or sustained by any party or parties by or from any of the acts of omissions or through the negligence of CONTRACTOR, its Subcontractors, Suppliers, servants, agents, or employees in connection with the Work and then from any and all claims arising under the Workmen's Compensation Act of the State of Michigan.

IN WITNESS WHEREOF, the parties hereto have caused this Maintenance and Guarantee Bond to be executed by their respective authorized officers this _____ day of _____, 20__.

Signed, sealed and delivered in the presence of:

Witness for CONTRACTOR

(Principal)

(Title)

By _____

Witness for Surety

(Surety)

(Title)

By _____

Attorney-In-Fact (Seal)

Address

Address of Surety

City

Zip Code

City

Zip Code

Telephone

Telephone

Section 00 6275
Engineer's Certificate for Payment

Job Number: _____ Certificate Number: _____ Date: _____

OWNER: _____

CONTRACTOR: _____

Project: _____

Contract Date: _____

Substantial Completion Date: _____ Extended To: _____

Completion Date: _____ Extended To: _____

Original Contract Price.....	Total Earned To Date.....
Adjustments to Quantities.....	Retention.....
Extras.....	Deductions.....
Total Change Orders.....	Total Withheld.....
Amended Contract Price.....	Total Net Due.....
Less Total Net Due.....	Less Previous Certificates.....
Balance on Contract.....	Total Balance Due this Certificate.....

ENGINEER'S CERTIFICATE FOR PAYMENT

In accordance with the Contract Documents, based on the data comprising the above application, the ENGINEER to the best of his knowledge, information, and belief and subject to the limitations stated in the Contract Documents certifies to the OWNER that: (1) Work has progressed to the point indicated, (2) that the quality of the Work is in accordance with the Contract Documents, and (3) the CONTRACTOR is entitled to payment of the Total Balance Due This Certificate.

Certified _____
ENGINEER Date

Recommended _____
Date

Section 00 6276
Contractor's Application for Payment

Job No. _____ Application No. _____ Date _____

OWNER: _____

CONTRACTOR: _____

Project: _____

Period of this Application for Payment and Declaration _____ to _____

Contract Dated _____

CONTRACTOR'S CERTIFICATION

Total Earned to Date.....\$ _____

Less Total Earned to Date.....\$ _____

Previous Certificate No. _____

Total Earned This Application.....\$ _____

The undersigned CONTRACTOR certifies that to the best of his knowledge, information, and belief the Work covered by this Application for Payment has been completed in accordance with the Contract Documents, that all amounts have been paid by him for Work for which previous Certificates for Payment were issued and payments received from the OWNER, and that current payment shows herein is now due.

(CONTRACTOR)

By: _____

Title: _____

CONTRACTOR'S DECLARATION

I hereby declare that I have not, during the period covered by this Application, performed any work, furnished any material, sustained any loss, damage, or delay for any reason, including soil conditions encountered or created, or otherwise done anything for which I shall ask, demand, sue for, or claim compensation from the OWNER, or its agents, and the ENGINEER, or its agents, in addition to the regular items set forth in the Contract as dated above executed between myself and the OWNER, and in the Change Orders for Work issued by the OWNER in writing as provided thereunder, except as I hereby make claim for additional compensation and/or extension of time, as set forth on the itemized statement attached hereto.

(CONTRACTOR)

By: _____

Title: _____

Section 00 6277

Payment Schedule

Job No. _____ Application No. _____ Date _____

Project: _____ Period: _____

Item of Work	Unit	Original Est. Quantity	Unit Price	Period Quantity	Period Amount	Total Quantity to Date	Total Amount to Date

Section 00 6325 Substitution Request Form

Specification Section # _____

Article # _____

Specified Product _____

Proposed Substitution _____

- | | | |
|----|--|---|
| A. | Does specified product exceed, in any respect proposed substitution? | <input type="checkbox"/> Y <input type="checkbox"/> N |
| B. | Does substitution affect dimensions shown on Plans? | <input type="checkbox"/> Y <input type="checkbox"/> N |
| C. | Does substitution affect other trades more than original product? | <input type="checkbox"/> Y <input type="checkbox"/> N |
| D. | Does warranty differ from that specified? | <input type="checkbox"/> Y <input type="checkbox"/> N |
| E. | Does substitution affect cost to OWNER? | <input type="checkbox"/> Y <input type="checkbox"/> N |
| F. | Does substitution result in any license fee or royalty? | <input type="checkbox"/> Y <input type="checkbox"/> N |

If you indicated "Yes" to any of the items above, attach thorough explanation on your Company letterhead, as follows:

1. Explain any differences between proposed substitution and specified product.
2. Summarize experience with product and manufacturer in Project area.
3. Attach complete technical data and literature.

The undersigned states that the function, appearance, and quality of the proposed substitution is equivalent or superior to the specified item, and that all information above and attached is true and correct.

Submitted by: _____ Date Submitted: _____

Company: _____

Address: _____

Telephone: _____ Fax: _____

Signature: _____

For use by ENGINEER

ENGINEER'S RESPONSE	RESPONSE REQUIRED OF CONTRACTOR
No Exceptions Taken <input type="checkbox"/>	None <input type="checkbox"/>
Note Markings <input type="checkbox"/>	Confirm <input type="checkbox"/>
Comments Attached <input type="checkbox"/>	Resubmit <input type="checkbox"/>
Rejected <input type="checkbox"/>	
<p>Engineer's review is for general conformance with the design concept and contract documents. Markings or comments should not be construed as relieving the contractor from compliance with the project plans and specifications, nor departures therefrom. The contractor remains responsible for details and accuracy, for confirming and correlating all quantities and dimensions, for selecting fabrication processes, for techniques of assembly, and for performing his work in a safe manner.</p> <p>By _____ Date _____</p>	

(CONTINUED)

That the CONTRACTOR has not procured material from, or subcontracted with, any person other than those set forth on the reverse side and owes no money for the improvement other than the sums set forth on the reverse side.

Deponent further says that he or she makes the foregoing statement as the (CONTRACTOR) (Subcontractor) or as _____ of the (CONTRACTOR) (Subcontractor) for the purpose of representing to the OWNER or lessee of the described on the reverse side premises and his or her agents that the property described on the reverse side is free from claims of construction liens, or the possibility of construction liens, except as specifically set forth on the reverse side and except for claims of construction liens by laborers which may be provided pursuant to section 109 of the construction lien act, Act No. 497 of the Public Acts of 1980, as amended, being section 570.1109 of the Michigan Compiled Laws.

WARNING TO OWNER: AN OWNER OR LESSEE OF THE PROPERTY DESCRIBED ON THE REVERSE SIDE MAY NOT RELY ON THIS SWORN STATEMENT TO AVOID THE CLAIM OF A SUBCONTRACTOR, SUPPLIER, OR LABORER WHO HAS PROVIDED A NOTICE OF FURNISHING OR A LABORER WHO MAY PROVIDE A NOTICE OF FURNISHING PURSUANT TO SECTION 109 OF THE CONSTRUCTION LIEN ACT TO THE DESIGNEE OR TO THE OWNER OR LESSEE IF THE DESIGNEE IS NOT NAMED OR HAS DIED.

(Deponent)

WARNING TO DEPONENT: A PERSON, WHO WITH INTENT TO DEFRAUD, GIVES A FALSE SWORN STATEMENT IS SUBJECT TO CRIMINAL PENALTIES AS PROVIDED IN SECTION 110 OF THE CONSTRUCTION LIEN ACT, ACT NO. 497 OF THE PUBLIC ACTS OF 1980, AS AMENDED, BEING SECTION 570.1110 OF THE MICHIGAN COMPILED LAWS.

Subscribed and sworn to before me this _____ day of _____, 20_____.

Notary Public

_____ County, Michigan

My Commission Expires _____

INSTRUCTIONS

1. A Sworn Statement in the preceding form must be provided before any CONTRACTOR or Subcontractor can file a Complaint, Cross-Claim, or Counter-Claim to enforce a construction lien.
2. An OWNER or lessee may withhold payment to a CONTRACTOR or Subcontractor who has not provided a Sworn Statement. An OWNER or lessee may withhold from a CONTRACTOR or Subcontractor who has provided a Sworn Statement the amount sufficient to pay all sums shown on the statement as owing Subcontractors, Suppliers, and laborers, or the amount shown to be due to lien claimants who have provided Notices of Furnishing pursuant to the Construction Lien Act of 1980.
3. An OWNER or lessee may rely on a Sworn Statement to avoid a lien claim unless the lien claimant has provided the OWNER or lessee with a Notice of Furnishing pursuant to the Construction Lien Act of 1980.
4. If the contract provides for payments by the OWNER to the general contractor, if any, in the normal course of construction, but the OWNER elects to pay lien claimants directly, the first time the OWNER elects to make payment directly to a lien claimant he or she shall provide at least 5 business days' notice to the general contractor of the intention to make direct payment. Subsequent direct disbursements to lien claimants need not be preceded by the 5-day notice provided in this section unless the OWNER first returns to the practice of paying all sums to the general contractor.

Section 00 6521

Prevailing Federal Wage Rate – Davis Bacon Act

Part 1 General

1.01 Summary

- A. P.L. 111-88 requires compliance with the Davis Bacon Act and adherence to the current U.S. Department of Labor Wage Decision. Attention is called to the fact that not less than the minimum salaries and wages as set forth in the Contract Documents (see Wage Decision included herein) must be paid on this project. The Wage Decision, including modifications, must be posted by the Contractor on the job site. A copy of the Federal Labor Standards Provisions is included and is hereby a part of this contract.
- B. In case there is an omission of any trade from the list of wage and fringe benefit rates to be paid to each class of mechanic by CONTRACTOR, it shall be understood that the trades omitted shall also be paid not less than the wage and fringe benefit rates prevailing in the locality in which the work is to be performed.
- C. A finding by the U.S. Department of Labor's Wage and Hour Division that CONTRACTOR or subcontractor is in violation of the requirements of the contract shall be final.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

End of Section

See Next Page for Wage Rate Determination.

"General Decision Number: MI20200083 01/24/2020

Superseded General Decision Number: MI20190083

State: Michigan

Construction Type: Building

County: Genesee County in Michigan.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories).

Note: Under Executive Order (EO) 13658, an hourly minimum wage of \$10.80 for calendar year 2020 applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least \$10.80 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in calendar year 2020. If this contract is covered by the EO and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must pay workers in that classification at least the wage rate determined through the conformance process set forth in 29 CFR 5.5(a)(1)(ii) (or the EO minimum wage rate, if it is higher than the conformed wage rate). The EO minimum wage rate will be adjusted annually. Please note that this EO applies to the above-mentioned types of contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but it does not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60). Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/03/2020
1	01/24/2020

ASBE0047-002 07/01/2019

	Rates	Fringes
ASBESTOS WORKER/HEAT & FROST INSULATOR.....	\$ 31.82	17.88

BOIL0169-001 03/01/2018

	Rates	Fringes
BOILERMAKER.....	\$ 38.65	26.22

BRMI0009-014 08/01/2019

	Rates	Fringes
BRICKLAYER.....	\$ 33.23	21.28
TILE FINISHER.....	\$ 29.93	18.02
TILE SETTER.....	\$ 29.93	18.02

FOOTNOTE:

Paid Holiday: Fourth of July, if the worker was employed by the contractor in any period of seven working days before said holiday within the current calendar year.

CARP0706-001 06/01/2019

	Rates	Fringes
CARPENTER, Includes		
Acoustical Ceiling		
Installation, Drywall		
Hanging, Form Work, and Metal		
Stud Installation.....	\$ 27.21	21.54

* ELEC0948-001 11/25/2019

	Rates	Fringes
ELECTRICIAN		
Excludes Low Voltage Wiring.	\$ 38.31	23.06
Low Voltage Wiring.....	\$ 29.46	17.12

ENGI0324-011 06/01/2019

	Rates	Fringes
OPERATOR: Power Equipment		
GROUP 1.....	\$ 39.58	24.35
GROUP 2.....	\$ 36.28	24.35
GROUP 3.....	\$ 33.63	24.35
GROUP 4.....	\$ 31.92	24.35
GROUP 5.....	\$ 31.92	24.35
GROUP 6.....	\$ 26.06	24.35
GROUP 7.....	\$ 23.58	24.35

FOOTNOTES:

Crane operator with main boom and jib 300' or longer: \$1.50 per hour above the group 1 rate. Crane operator with main boom and jib 400' or longer: \$3.00 per hour above the group 1 rate.

PAID HOLIDAYS: New Year's Day, Memorial Day, Fourth of July, Labor Day, Thanksgiving Day and Christmas Day.

POWER EQUIPMENT OPERATOR CLASSIFICATIONS

GROUP 1: Crane operator with main boom and jib 400', 300', or 220' or longer.

GROUP 2: Crane operator with main boom and jib 140' or longer, tower crane, gantry crane, whirley derrick

GROUP 3: Backhoe/Excavator/Trackhoe; Bulldozer; Concrete Pump; Crane; Grader/Blade; Highlift; Hoist; Loader; Roller; Scraper; Stiff Leg Derrick; Tractor; Trencher

GROUP 4: Bobcat/Skid Loader; Broom/Sweeper; Fork Truck (over 20' lift)

GROUP 5: Boom Truck (non-swinging)

GROUP 6: Fork Truck (20' lift and under for masonry work)

GROUP 7: Oiler

IRON0025-019 06/01/2019

	Rates	Fringes
IRONWORKER		
REINFORCING.....	\$ 30.98	27.99
STRUCTURAL.....	\$ 36.77	29.03

LAB00334-005 06/01/2019

	Rates	Fringes
LABORER: Landscape & Irrigation		
GROUP 1.....	\$ 20.75	7.10
GROUP 2.....	\$ 18.75	7.10

CLASSIFICATIONS

GROUP 1: Landscape specialist, including air, gas and diesel equipment operator, lawn sprinkler installer, skidsteer (or equivalent)

GROUP 2: Landscape laborer: small power tool operator, material mover, truck driver and lawn sprinkler installer tender

LAB01075-002 06/01/2019

	Rates	Fringes
LABORER		
Common or General; Grade Checker; Mason Tender - Brick/Cement/Concrete, Pipelaye; Sandblaster.....	\$ 23.00	13.66

PAIN1052-001 06/01/2018

	Rates	Fringes
PAINTER		
Brush & Roler.....	\$ 24.40	12.95
Spray.....	\$ 25.75	12.95

PAIN1052-004 06/01/2018

	Rates	Fringes
DRYWALL FINISHER/TAPER		
Drywall sanding.....	\$ 26.07	13.50
Hand work.....	\$ 26.07	13.50
Machine work.....	\$ 26.07	13.50

PLAS0016-005 04/01/2014

	Rates	Fringes
CEMENT MASON/CONCRETE FINISHER...	\$ 25.58	12.88

PLUM0370-002 06/01/2018

	Rates	Fringes
PIPEFITTER (Includes HVAC Pipe Installation; Excludes HVAC System Installation).....	\$ 37.81	20.60
PLUMBER, Excludes HVAC Pipe Installation.....	\$ 37.81	20.60

ROOF0149-005 06/01/2019

	Rates	Fringes
ROOFER.....	\$ 28.53	17.53

SFMI0669-001 04/01/2019

	Rates	Fringes
SPRINKLER FITTER (Fire Sprinklers).....	\$ 35.62	21.97

SHEE0007-008 05/01/2018

	Rates	Fringes
SHEET METAL WORKER, Includes HVAC Duct and Unit Installation.....	\$ 30.64	22.76

SUMI2011-008 02/01/2011

	Rates	Fringes
IRONWORKER, ORNAMENTAL.....	\$ 18.48	7.93
TRUCK DRIVER: Tractor Haul Truck.....	\$ 13.57	1.18

WELDERS - Receive rate prescribed for craft performing
operation to which welding is incidental.

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Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of ""identifiers"" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than ""SU"" or ""UAVG"" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union

average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- * an existing published wage determination
- * a survey underlying a wage determination
- * a Wage and Hour Division letter setting forth a position on a wage determination matter
- * a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.

Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION"

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Article 1 Definitions

1.01 Defined Terms

- A. Wherever used in these General Conditions or in the other Contract Documents, the following terms have the meanings indicated which are applicable to both the singular and plural thereof:
1. Addenda -- Written or graphic instruments issued prior to the opening of Bids which clarify, correct or change the Contract Documents.
 2. Agreement -- The written Agreement between OWNER and CONTRACTOR covering the Work to be performed; other Contract Documents are attached to the Agreement and made a part thereof as provided therein.
 3. Application and Certificate for Payment -- The form included in the Contract Documents which is to be used by CONTRACTOR in requesting progress or final payment and which is to be accompanied by such supporting documentation as is required by the Contract Documents.
 4. Bid -- The offer or proposal of the bidder submitted on the prescribed form setting forth the price(s) for the Work to be performed.
 5. Bidding Requirements -- The Advertisement for Bids, Instructions to Bidders, Supplementary Instructions to Bidders, Proposal, Legal Status of Bidder, Bid Bond, and any other documents identified in the Proposal, to be submitted with the Bid.
 6. Bonds -- Bid, Performance and Payment bonds and other instruments of security.
 7. Change Order -- A written order to CONTRACTOR, reviewed by the ENGINEER and signed by OWNER, issued after execution of the Contract, authorizing a change in the Work or an adjustment in the Contract Price or the Contract Time. The Contract Price and Contract Time may be changed only by Change Order. A Change Order signed by CONTRACTOR indicates his agreement therewith, including that the Change Order constitutes a final adjustment in the Contract Price or Contract Time for all issues addressed or described in the Change Order.
 8. Change Proposal -- A written request by CONTRACTOR, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment in Contract Price or Contract Times; contesting an initial decision by ENGINEER concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; challenging a set-off against payments due; or seeking other relief with respect to the terms of the Contract.
 9. Claims --
 - a. A demand or assertion by OWNER directly to CONTRACTOR, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment of Contract Price or Contract Times; contesting an initial decision by ENGINEER concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; contesting ENGINEER's

decision regarding a Change Proposal; seeking resolution of a contractual issue that ENGINEER has declined to address; or seeking other relief with respect to the terms of the Contract.

- b. A demand or assertion by CONTRACTOR directly to OWNER, duly submitted in compliance with the procedural requirements set forth herein, contesting ENGINEER's decision regarding a Change Proposal, or seeking resolution of a contractual issue that ENGINEER has declined to address.
 - c. A demand or assertion by OWNER or CONTRACTOR, duly submitted in compliance with the procedural requirements set forth herein, arising after ENGINEER has issued a recommendation of final payment.
 - d. A demand for money or services by a third party is not a Claim.
- 10. Constituents of Concern -- Asbestos, petroleum, radioactive materials, polychlorinated biphenyls (PCBs), lead-based paint (as defined by the HUD/EPA standard), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to Laws and Regulations regulating, relating to, or imposing liability or standards of conduct concerning, any hazardous, toxic, or dangerous waste, substance, or material.
 - 11. Contract -- The entire and integrated written contract between OWNER and CONTRACTOR concerning the Work
 - 12. Contract Documents -- Those items so designated in the Agreement, and which together comprise the Contract.
 - 13. Contract Price -- The monies or other considerations payable by OWNER to CONTRACTOR for completion of acceptable Work in accordance with the Contract Documents as stated in the Agreement.
 - 14. Contract Time -- The number of days or the date stated in the Agreement:
 - a. to achieve Substantial Completion of all or any specified portions of the Work, and;
 - b. to complete the Work so that it is ready for final payment as evidenced by ENGINEER's written recommendation of final payment in accordance with paragraph 14.11.
 - 15. CONTRACTOR -- The person, firm or corporation with whom OWNER has entered into the Agreement.
 - 16. Cost of the Work -- The term Cost of the Work means the sum of all costs necessary for the proper performance of the Work at issue, as further defined in paragraph 12.01.
 - 17. Day -- A calendar day of 24 hours measured from midnight to the next midnight.

18. Defective -- An adjective which when modifying the word Work refers to Work that is unsatisfactory, faulty or deficient, in that it does not conform to the Contract Documents or does not meet the requirements of any inspection, reference standard, test or approval referred to in the Contract Documents, or has been damaged prior to ENGINEER's recommendation of final payment.
19. Drawings -- See Plans.
20. Effective Date of Agreement -- The date indicated in the Agreement on which it becomes effective, but if no such date is indicated it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.
21. Electronic Document -- Any Project-related correspondence, attachments to correspondence, data, documents, drawings, information, or graphics, including but not limited to Shop Drawings and other Submittals, that are in an electronic or digital format.
22. Electronic Means -- Electronic mail (email), upload/download from a secure Project website, or other communications methods that allow:
 - a. the transmission or communication of Electronic Documents;
 - b. the documentation of transmissions, including sending and receipt;
 - c. printing of the transmitted Electronic Document by the recipient;
 - d. the storage and archiving of the Electronic Document by sender and recipient; and
 - e. the use by recipient of the Electronic Document for purposes permitted by this Contract. Electronic Means does not include the use of text messaging, or of Facebook, Twitter, Instagram, or similar social media services for transmission of Electronic Documents.
23. ENGINEER -- The person, firm, or corporation identified in the Supplementary Instructions to Bidders hired by OWNER to prepare Plans and Specifications for the Project and to assist OWNER in interpreting Plans and Specifications during the performance of the Work. ENGINEER's authority and responsibility are set forth in the Contract between OWNER and ENGINEER. CONTRACTOR acknowledges and agrees that ENGINEER's obligations and duties under ENGINEER's contract with OWNER are obligations and duties to OWNER only, and ENGINEER has no independent obligation to CONTRACTOR of any kind, including but not limited to providing services, or to take any action or to refrain from taking action on behalf of CONTRACTOR or any Subcontractor, Sub-Subcontractor or Supplier.
24. Field Order -- A written order issued by ENGINEER which clarifies or interprets the Contract Documents or orders minor changes in the Work in accordance with paragraphs 9.04 and 9.05 but which does not involve a change in the Contract Price or the Contract Time.
25. Hazardous Environmental Conditions -- The presence at the Site of Constituents of Concern in such quantities or circumstances that may present a danger to persons or property exposed thereto.

- a. The presence at the Site of materials that are necessary for the execution of the Work, or that are to be incorporated into the Work, and that are controlled and contained pursuant to industry practices, Laws and Regulations, and the requirements of the Contract, is not a Hazardous Environmental Condition.
 - b. The presence of Constituents of Concern that are to be removed or remediated as part of the Work is not a Hazardous Environmental Condition.
 - c. The presence of Constituents of Concern as part of the routine, anticipated, and obvious working conditions at the Site, is not a Hazardous Environmental Condition.
- 26. Laws and Regulations; Laws or Regulations Any and all applicable laws, rules, regulations, ordinances, codes and orders of any and all governmental bodies, agencies, authorities and courts having jurisdiction.
 - 27. Lump Sum -- Construction Work where the OWNER pays a single stipulate price (Lump Sum) for the entire scope of Work; plus or minus alternates and/or allowances. However, unit prices may be required for individual items of Work for the purposes of changes, additions, or deletions.
 - 28. Milestone -- A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of the Work.
 - 29. Notice of Award -- The written notice by OWNER to the apparent successful Bidder stating that, upon compliance by the apparent successful Bidder with the conditions precedent enumerated therein, within the time specified, OWNER will sign and deliver the Agreement.
 - 30. Notice to Proceed -- A written notice given by OWNER to CONTRACTOR (with a copy to ENGINEER) fixing the date on which the Contract Time will commence to run and on which CONTRACTOR shall start to perform his obligation under the Contract Documents.
 - 31. OWNER -- The public body or authority, corporation, limited liability company, association, partnership, or individual with whom CONTRACTOR has entered into the Agreement and for whom the Work is to be provided and as identified in the Supplementary Instructions to Bidders.
 - 32. Partial Utilization -- Use by OWNER of a substantially completed part of the Work for the purpose for which it is intended (or a related purpose) prior to Substantial Completion of all the Work.
 - 33. Plans -- The part of the Contract Documents which graphically show the extent, character and Scope of the Work to be furnished and performed by CONTRACTOR and which have been prepared or approved by the ENGINEER or OWNER; sometimes also referred to as Drawings.
 - 34. Progress Schedule -- A schedule, prepared and maintained by CONTRACTOR, describing the sequence and duration of the activities comprising CONTRACTOR's plan to accomplish the Work within the Contract Times.

35. Project -- The total construction of which the Work to be provided under the Contract Documents may be the whole or a part as indicated elsewhere in the Contract Documents.
36. Project Manual -- The volume assembled for the Project which may include, among other parts, Procurement Requirements, Contracting Requirements and Specifications.
37. Proposal -- The offer or bid of the Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.
38. Radioactive Material -- Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 as amended.
39. Resident Project Representative -- The authorized representative of ENGINEER who may be assigned to the Site or any part thereof.
40. Samples -- Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.
41. Schedule of Submittals -- A schedule, prepared and maintained by CONTRACTOR, of required Submittals and the time requirements for ENGINEER's review of the Submittals.
42. Schedule of Values -- A schedule, prepared and maintained by CONTRACTOR, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing CONTRACTOR's Applications for Payment.
43. Shop Drawings -- All drawings, diagrams, illustrations, schedules and other data or information required by the Contract Documents which are specifically prepared or assembled by or for CONTRACTOR and submitted by CONTRACTOR to illustrate material or equipment for some portion of the Work.
44. Site -- Lands or areas indicated in the Contract Documents as being furnished by OWNER upon which the Work is to be performed, including rights-of-way and easements, and such other lands or areas furnished by OWNER which are designated for the use of CONTRACTOR.
45. Specifications -- That part of the Contract Documents which consist of written technical descriptions of materials, equipment, construction systems, standards and workmanship as applied to the Work and certain administrative details applicable thereto.
 - a. Project Specifications are those portions of the Contract Documents which have been prepared specifically for this Project and which are identified by the job number in the lower right-hand corner of each page.
 - b. Standard Specifications are Specification sections that are the same from Project to Project as of the revision date shown in the lower left-hand corner of the page.
 - c. Standard Specification Section Revisions -- Section 00 9120 of the Specifications which amends or supplements the Standard Specification Sections.

- 46. Subcontractor -- An individual, firm or corporation having a direct contract with CONTRACTOR or with any other Subcontractor for the performance of a part of the Work at the Site.
- 47. Submittal -- A written or graphic document, prepared by or for CONTRACTOR, which the Contract Documents require CONTRACTOR to submit to ENGINEER, or that is indicated as a Submittal in the Schedule of Submittals accepted by ENGINEER. Submittals may include Shop Drawings and Samples; schedules; product data; OWNER-delegated designs; sustainable design information; information on special procedures; testing plans; results of tests and evaluations, source quality-control testing and inspections, and field or Site quality-control testing and inspections; warranties and certifications; Suppliers' instructions and reports; records of delivery of spare parts and tools; operations and maintenance data; Project photographic documentation; record documents; and other such documents required by the Contract Documents. Submittals, whether or not approved or accepted by ENGINEER, are not Contract Documents. Change Proposals, Change Orders, Claims, notices, Applications for Payment, and requests for interpretation or clarification are not Submittals.
- 48. Substantial Completion -- The Work (or a specified part thereof) has progressed to the point where, in the opinion of ENGINEER as evidenced by the Certificate of Substantial Completion, it is sufficiently complete, in accordance with the Contract Documents, so that the Work (or specified part) can be utilized for the purposes for which it was intended; or if no such certificate is issued, when the Work is complete and ready for final payment as evidenced by ENGINEER's written recommendation of final payment in accordance with paragraph 14.11. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof.
- 49. Supplementary Conditions -- The part of the Contract Documents which amends or supplements these General Conditions.
- 50. Supplementary Instructions to Bidders -- The part of the Contract Documents which amends or supplements the Instructions to Bidders.
- 51. Supplier -- A manufacturer, fabricator, supplier, distributor, material man, or vendor having a direct contract with CONTRACTOR, or with any Subcontractor, or with OWNER, to furnish materials or equipment to be incorporated in the Work by CONTRACTOR or any Subcontractor.
- 52. Unit Price -- Construction Work where the OWNER pays a fixed sum (Unit Price) per each completed unit of Work. Units are listed on the Proposal Form.
- 53. Utilities -- Underground or above ground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels or other such facilities or attachments, and any structures or encasements containing such facilities, which have been installed to furnish any of the following services or materials: electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, sewage and drainage removal, traffic or other control systems, water or other liquids or chemicals.

- 54. Work -- The entire completed construction or the various separately identifiable parts thereof required to be furnished under the Contract Documents. Work includes and is the result of performing or furnishing labor and furnishing and incorporating materials and equipment into the construction, and performing or furnishing services and furnishing documents, all as required by the Contract Documents.
- 55. Work Change Directive -- A written directive to CONTRACTOR, issued on or after the Effective Date of the Agreement and signed by OWNER and reviewed by ENGINEER, ordering an addition, deletion or revision in the Work, or responding to differing or unforeseen physical conditions under which the Work is to be performed as provided in paragraph 4.03 or to emergencies under paragraph 6.18. A Work Change Directive will not change the Contract Price or Contract Time but is evidence that the parties expect that the change directed or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Time as provided in paragraph 10.01.

1.02 Terminology

- A. The following words, terms, or phrases are not defined but, when used in the Contract Documents, have the following meaning:
 - 1. Whenever in the Contract Documents the terms “as ordered,” “as directed,” “as required,” “as allowed,” “as approved” or terms of like effect or import are used; or the adjectives “reasonable,” “suitable,” “acceptable,” “proper” or “satisfactory” or adjectives of like effect or import are used to describe a requirement, direction, review or judgment of ENGINEER as to the Work, it is intended that such requirement, direction, review or judgment will be solely to evaluate, in general, the completed Work for compliance with the technical requirements of and information in the Contract Documents and conformance with the design concept of the completed Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective shall not be effective to assign to ENGINEER any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility contrary to the provisions of paragraph 9.10 or any other provision of the Contract Documents.
 - 2. The word “furnish,” when used in connection with services, materials, or equipment, shall mean to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.
 - 3. The word “install,” when used in connection with services, materials, or equipment, shall mean to put into use or place in final position said services, materials, or equipment complete and ready for intended use.
 - 4. The words “perform” or “provide,” when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.
 - 5. When “furnish,” “install,” “perform,” or “provide” is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of CONTRACTOR, “provide” is implied.

- B. Unless stated otherwise in the Contract Documents, words or phrases which have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

Article 2 Preliminary Matters

2.01 Delivery of Bonds and Insurance

- A. When CONTRACTOR delivers the executed Agreements to OWNER, CONTRACTOR shall also deliver to OWNER such Bonds and Insurance Certificates and other evidence of Insurance requested as CONTRACTOR may be required to furnish in accordance with Article 5. No Work at the site may begin or progress payments made to CONTRACTOR until all Bonds and Insurance Certificates in the form and substance required in Article 5 have been submitted and approved by OWNER.

2.02 Copies of Documents

- A. OWNER shall furnish to CONTRACTOR up to 5 copies of the Contract Documents (including at least one fully signed counterpart of the Agreement) as are reasonably necessary for the execution of the Work. Additional copies will be furnished, upon request, at the cost of reproduction.

2.03 Commencement of Contract Time; Notice to Proceed

- A. Time is of the essence in the performance of the Work. The Contract Time will commence to run on the 30th day after the effective date of the Agreement, or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the effective date of the Agreement. In no event will the Contract Time commence to run later than the 30th day after the effective date of the Agreement. Time limits stated in the Contract Documents are of the essence of the Agreement.

2.04 Starting the Project

- A. CONTRACTOR shall start to perform the Work within 10 days of when the Contract Time commences to run, but no Work shall be done at the Site prior to the date on which the Contract Time commences to run. CONTRACTOR shall notify the ENGINEER at least 3 working days in advance of the time he intends to start Work.

2.05 Preconstruction Meeting

- A. Within 10 days of the Effective Date of the Agreement and prior to the delivery of materials or the start of any construction, the CONTRACTOR shall request a Preconstruction Meeting from ENGINEER. A minimum of 3 full working days' notice shall be required.
- B. Prior to the scheduling of the Preconstruction Meeting, CONTRACTOR shall submit to ENGINEER for review:
 - 1. A preliminary Progress Schedule indicating the starting and completion dates of the various stages of the Work, including any Milestones specified in the Contract Documents;
 - 2. A preliminary Schedule of Submittals which will list each required Submittal and the times for submitting, reviewing and processing such Submittal;
 - 3. An estimated monthly payment schedule, and a preliminary Schedule of Values for all of the Work.

- C. The Preconstruction Meeting will be held for review and acceptance of the schedules, to establish procedures for handling Shop Drawings and other Submittals, for processing Applications for Payment, and to establish a working understanding among the parties as to the Work.

2.06 Electronic Transmittals

- A. Except as otherwise stated elsewhere in the Contract, the OWNER, ENGINEER, and CONTRACTOR may send, and shall accept, Electronic Documents transmitted by Electronic Means.
- B. If the Contract does not establish protocols for Electronic Means, then OWNER, ENGINEER, and CONTRACTOR shall jointly develop such protocols.
- C. Subject to any governing protocols for Electronic Means, when transmitting Electronic Documents by Electronic Means, the transmitting party makes no representations as to long-term compatibility, usability, or readability of the Electronic Documents resulting from the recipient's use of software application packages, operating systems, or computer hardware differing from those used in the drafting or transmittal of the Electronic Documents.

Article 3 Contract Documents Intent and Reuse

3.01 Intent

- A. The Contract Documents are complementary; what is required by one Contract Document is as binding as if required by all.
- B. It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents.
- C. Unless otherwise stated in the Contract Documents, if there is a discrepancy between the electronic versions of the Contract Documents (including any printed copies derived from such electronic versions) and the printed record version, the printed record version will govern.
- D. The Contract supersedes prior negotiations, representations, and agreements, whether written or oral.
- E. ENGINEER will issue clarifications and interpretations of the Contract Documents as provided herein.
- F. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation will be deemed stricken, and all remaining provisions will continue to be valid and binding upon OWNER and CONTRACTOR, which agree that the Contract Documents will be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.
- G. Nothing in the Contract Documents creates:
 - 1. any contractual relationship between OWNER or ENGINEER and any Subcontractor, Supplier, or other individual or entity performing or furnishing any of the Work, for the benefit of such Subcontractor, Supplier, or other individual or entity; or
 - 2. any obligation on the part of OWNER or ENGINEER to pay or to see to the payment of any money due any such Subcontractor, Supplier, or other individual or entity, except as may otherwise be required by Laws and Regulations; or

3. any obligation on the part of ENGINEER to CONTRACTOR.

3.02 Reference to Standards and Specifications of Technical Societies

- A. Reference to standards, specifications, manuals or codes of any technical society, organization or association, or to the Laws or Regulations of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard, specification, manual, or Laws or Regulations in effect at the time of opening of Bids or, on the effective date of the Agreement if there were no Bids, except as may be otherwise specifically stated in the Contract Documents.
- B. It is the intent of the Contract Documents to describe a functionally complete project (or part thereof) to be constructed in accordance with the Contract Documents. Any Work, materials, or equipment that may reasonably be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the intended result shall be furnished and performed whether or not it is specifically called for.
- C. No provision of any standard, specification, manual, code or instruction shall be effective to change the duties and responsibilities of OWNER, CONTRACTOR or ENGINEER, or any of their Subcontractors, consultants, agents, or employees from those set forth in the Contract Documents, nor shall it be effective to assign to OWNER, ENGINEER or any of ENGINEER's consultants, agents or employees, any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of paragraph 9.10 or any other provision of the Contract Documents.

3.03 Reporting and Resolving Discrepancies

- A. Before undertaking each part of the Work, CONTRACTOR shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. CONTRACTOR has a duty to and shall promptly report in writing to ENGINEER any conflict, error, ambiguity, or discrepancy which CONTRACTOR should reasonably have discovered and shall obtain a written interpretation or clarification from ENGINEER before proceeding with any Work affected thereby.
- B. If, during the performance of the Work, CONTRACTOR discovers any conflict, error, ambiguity or discrepancy within the Contract Documents or between the Contract Documents and any provision of any Law or Regulation applicable to the performance of the Work or of any standard, specification, manual or code, or of any instruction of any Supplier, CONTRACTOR shall report it to ENGINEER in writing at once, and, CONTRACTOR shall not proceed with the Work affected thereby (except in an emergency as authorized by paragraph 6.18) until receiving written instruction or clarification from ENGINEER or OWNER. However, CONTRACTOR shall not be liable to OWNER or ENGINEER for failure to report any such conflict, error, ambiguity or discrepancy unless CONTRACTOR knew or reasonably should have known thereof.
- C. Except as otherwise specifically stated in the Contract Documents or as may be provided by amendment or supplement issued by one of the methods indicated in paragraph 3.05, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity or discrepancy between the provisions of the Contract Documents and;
 1. the provisions of any standard, specification, manual, code or instruction (whether or not specifically incorporated by reference in the Contract Documents); or

2. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 Requirements of Contract Documents

- A. During the performance of the Work and until final payment, CONTRACTOR and OWNER shall submit to the ENGINEER in writing all matters in question concerning the requirements of the Contract Documents (sometimes referred to as requests for information or interpretation—RFIs), or relating to the acceptability of the Work under the Contract Documents, as soon as possible after such matters arise. ENGINEER will be the initial interpreter of the requirements of the Contract Documents, and judge of the acceptability of the Work.
- B. ENGINEER will, with reasonable promptness, render a written clarification, interpretation, or decision on the issue submitted, or initiate an amendment or supplement to the Contract Documents. ENGINEER's written clarification, interpretation, or decision will be final and binding on CONTRACTOR, unless it appeals by submitting a Change Proposal, and on OWNER, unless it appeals by filing a Claim.
- C. If a submitted matter in question concerns terms and conditions of the Contract Documents that do not involve
 1. the performance or acceptability of the Work under the Contract Documents,
 2. the design (as set forth in the Drawings, Specifications, or otherwise), or
 3. other engineering or technical matters, then ENGINEER will promptly notify OWNER and CONTRACTOR in writing that ENGINEER is unable to provide a decision or interpretation. If OWNER and CONTRACTOR are unable to agree on resolution of such a matter in question, either party may pursue resolution as provided in paragraph 11.01.

3.05 Order of Precedence

- A. In resolving conflicts, errors or discrepancies between Plans and Specifications,
 1. figured dimensions shall govern over scaled dimensions;
 2. Plans shall govern over Standard Specifications;
 3. and Project Specifications shall govern over Standard Specifications and Plans.

3.06 Amending and Supplementing Contract Documents

- A. The Contract Documents may be amended to provide for additions, deletions and revisions in the Work or to modify the terms and conditions thereof in one or more of the following ways:
 1. a Field Order (pursuant to paragraph 9.05), or,
 2. a Change Order (pursuant to paragraph 10.01.A.1), or
 3. a Work Change Directive Order (pursuant to paragraph 10.01.A.2)
- B. In addition, the requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized, in one or more of the following ways:

1. a Field Order (pursuant to paragraph 9.05),
2. ENGINEER's review of a Shop Drawing or Sample (pursuant to paragraph 6.21), or
3. ENGINEER's written interpretation or clarification (pursuant to paragraph 9.04).

3.07 Reuse of Documents

- A. Neither CONTRACTOR nor any Subcontractor, manufacturer, fabricator, Supplier, distributor, or other person or organization performing or furnishing any of the Work under a direct or indirect contract with OWNER:
 1. shall have or acquire any title to or ownership rights in any of the Plans, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of ENGINEER or ENGINEER's Consultant, and
 2. they shall not reuse any of such Plans, Specification, other documents or copies on extensions of the Project or any other project without written consent of OWNER and ENGINEER and specific written verification or adaptation by ENGINEER.

3.08 Electronic Data

- A. Except as otherwise stated elsewhere in the Contract Documents, OWNER, ENGINEER and CONTRACTOR may transmit, and shall accept, Project-related correspondence, text, data, documents, drawings, information and graphics, including but not limited to Shop Drawings and other Submittals, in electronic media or digital format, either directly or through access to a secure Project website.
- B. When transferring documents in electronic media format, the transferring party makes no representations as to long term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by the data's creator.

Article 4 Availability of Lands; Subsurface and Physical Conditions; Reference Points

4.01 Availability of Lands

- A. OWNER shall furnish, as indicated in the Contract Documents and not later than the established date for beginning Work on the Contract, the lands upon which the Work is to be performed, rights of way and easements for access thereto, and such other lands which are designated for the use of CONTRACTOR. OWNER shall identify any encumbrances or restrictions not of general application but specifically related to use of lands so furnished with which CONTRACTOR will have to comply in performing the Work. Easements for permanent structures or permanent changes in existing facilities will be obtained and paid for by OWNER, unless otherwise provided in the Contract Documents. CONTRACTOR shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment unless otherwise provided in the Contract Documents.

4.02 Subsurface and Physical Conditions; Investigations and Reports

- A. Reference is made to the Supplementary Conditions for identification of those reports of investigations and tests of subsurface and physical conditions at the Site or otherwise affecting cost, progress or performance of the Work which have been reviewed in preparation of the Contract Documents. Such reports are not guaranteed as to accuracy or completeness and are not part of the Contract Documents.
- B. The locations of utilities or other physical conditions relating to existing surface or subsurface structures at or contiguous to the Site as shown on the Plans are taken from drawings from sources believed to be reliable. Neither the OWNER nor ENGINEER will be responsible for any omissions of, or variations from, the indicated location of existing utilities which may be encountered in the Work.
- C. CONTRACTOR shall draw its own conclusions as to the general accuracy of the "technical data" contained in such reports and drawings, and confirms such reports and drawings are not Contract Documents. CONTRACTOR may not rely upon or make any Claim against OWNER, ENGINEER or any of ENGINEER's Consultants with respect to:
 - a. the completeness of such reports and drawings for CONTRACTOR's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by CONTRACTOR and safety precautions and programs incident thereto, or
 - b. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings, or
 - c. any CONTRACTOR interpretation of or conclusion drawn from any "technical data" or any such data, interpretations, opinions or information.
- 2. The cost of all the following will be included in the Contract Price and CONTRACTOR shall have full responsibility for:
 - a. reviewing and checking all such information and data,
 - b. locating all Utilities during construction,
 - c. coordination of the Work with the owners of such Utilities, and
 - d. the safety and protection of all such Utilities as provided in paragraph 6.15 and repairing any damage thereto resulting from the Work.

4.03 Unforeseen Physical Conditions

- A. A. If CONTRACTOR discovers one or both of the following physical conditions of surface or subsurface at the Project or improvement Site, before disturbing the physical condition, the CONTRACTOR shall immediately notify OWNER and ENGINEER of the physical condition; and follow up within 48 hours in writing:
 - 1. A subsurface or a physical condition at the Site differing materially from those indicated in the Contract Documents, or
 - 2. An unknown physical condition at the Site of a nature differing materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for the improvement project.

- B. ENGINEER's Review. After receipt of written notice as required by the preceding paragraph, ENGINEER will promptly review the subsurface or physical condition in question; determine the necessity of OWNER's obtaining additional exploration or tests with respect to the condition; conclude whether the condition falls within any one or more of the differing site condition categories in paragraph 4.03.A above; obtain any pertinent cost or schedule information from CONTRACTOR; prepare recommendations to OWNER regarding the CONTRACTOR's resumption of Work in connection with the subsurface or physical condition in question and the need for any change in the Drawings or Specifications; and advise OWNER in writing of ENGINEER's findings, conclusions, and recommendations.
- C. OWNER's Statement to CONTRACTOR Regarding Site Condition. After receipt of ENGINEER's written findings, conclusions, and recommendations, OWNER shall issue a written statement to CONTRACTOR (with a copy to ENGINEER) regarding the subsurface or physical condition in question, addressing the resumption of Work in connection with such condition, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting ENGINEER's written findings, conclusions, and recommendations, in whole or in part.
- D. Possible Price and Times Adjustments.
 - 1. CONTRACTOR shall be entitled to an equitable adjustment in Contract Price or Contract Times, or both, to the extent that the existence of a differing subsurface or physical condition, or any related delay, disruption, or interference, causes an increase or decrease in CONTRACTOR's cost of, or time required for, performance of the Work; subject, however, to the following:
 - a. such condition must fall within any one or more of the categories described in paragraph 4.03.A;
 - b. with respect to Work that is paid for on a Unit Price basis, any adjustment in Contract Price will be subject to the provisions of paragraph 12.03; and
 - c. CONTRACTOR's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to CONTRACTOR's ability to complete the Work within the Contract Times pursuant to paragraph 10.05.
 - 2. CONTRACTOR shall not be entitled to any adjustment in the Contract Price or Contract Times with respect to a subsurface or physical condition if:
 - a. CONTRACTOR knew of the existence of such condition at the time CONTRACTOR made a commitment to OWNER with respect to Contract Price and Contract times by the submission of a Bid or becoming bound under a negotiated contract, or otherwise; or
 - b. the existence of such condition reasonably could have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas expressly required by the Bidding Requirements or Contract Documents to be conducted by or for CONTRACTOR prior to CONTRACTOR's making such commitment; or

- c. CONTRACTOR failed to give the written notice as required by paragraph 4.03.A.
3. If OWNER and CONTRACTOR agree regarding CONTRACTOR's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, or both, then any such adjustment shall be set forth in a Change Order or Work Change Directive.
4. CONTRACTOR may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, or both, no later than 30 days after OWNER's issuance of the OWNER's written statement to CONTRACTOR regarding the subsurface or physical condition in question.

4.04 Utilities

- A. CONTRACTOR's Responsibilities. The information and data shown or indicated in the Contract Documents with respect to existing Utilities at or adjacent to the Site, if any, is based on information and data furnished to OWNER or ENGINEER by the owners of such Utilities, including OWNER, or by others.
 1. OWNER and ENGINEER do not warrant or guarantee the accuracy or completeness of any such information or data provided by others; and
 2. the cost of all of the following will be included in the Contract Price, and CONTRACTOR shall have full responsibility for:
 - a. reviewing and checking all information and data regarding existing Utilities at the Site;
 - b. locating all Utilities shown or indicated in the Contract Documents as being at the Site;
 - c. coordination of the Work with the owners (including OWNER) of such Utilities, during construction; and
 - d. the safety and protection of all existing Utilities at the Site, and repairing any damage thereto resulting from the Work.
- B. Notice by CONTRACTOR. If CONTRACTOR believes that an Utilities that is uncovered or revealed at the Site was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy, then CONTRACTOR shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by paragraph 6.18), identify the owner of such Underground Facility and give written notice to that owner and to OWNER and ENGINEER.
- C. ENGINEER's Review. ENGINEER will:
 1. promptly review the Utilities and conclude whether such Utilities was not shown or indicated in the Contract Documents,
 2. or was not shown or indicated with reasonable accuracy;
 3. obtain any pertinent cost or schedule information from CONTRACTOR;
 4. prepare recommendations to OWNER regarding the CONTRACTOR's resumption of Work in connection with the Utilities in question;

5. determine the extent, if any, to which a change is required in the Drawings or Specifications to reflect and document the consequences of the existence or location of the Utilities;
6. and advise OWNER in writing of ENGINEER's findings, conclusions, and recommendations.

During such time, CONTRACTOR shall be responsible for the safety and protection of such Underground Facility.

- D. OWNER's Statement to CONTRACTOR Regarding Utilities. After receipt of ENGINEER's written findings, conclusions, and recommendations, OWNER shall issue a written statement to CONTRACTOR (with a copy to ENGINEER) regarding the Utilities in question, addressing the resumption of Work in connection with such Underground Facility, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting ENGINEER's written findings, conclusions, and recommendations in whole or in part.

- E. Possible Price and Times Adjustments:

1. CONTRACTOR shall be entitled to an equitable adjustment in the Contract Price or Contract Times, or both, to the extent that any existing Utilities at the Site that was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy, or any related delay, disruption, or interference, causes an increase or decrease in CONTRACTOR's cost of, or time required for, performance of the Work; subject, however, to the following:
 - a. CONTRACTOR did not know of and could not reasonably have been expected to be aware of or to have anticipated the existence or actual location of the Utilities in question;
 - b. With respect to Work that is paid for on a Unit Price basis, any adjustment in Contract Price will be subject to the provisions of paragraph 12.03;
 - c. CONTRACTOR's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to CONTRACTOR's ability to complete the Work within the Contract Times; and
 - d. CONTRACTOR gave the notice required in paragraph 4.04.B.
2. If OWNER and CONTRACTOR agree regarding CONTRACTOR's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, or both, then any such adjustment shall be set forth in a Change Order.
3. CONTRACTOR may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, or both, no later than 30 days after OWNER's issuance of the OWNER's written statement to CONTRACTOR regarding the Underground Facility in question.

4.05 Reference Points

- A. OWNER shall provide engineering surveys for construction to establish property corners, monuments, bench marks and similar reference points which in his judgment are necessary to enable CONTRACTOR to proceed with the Work. CONTRACTOR shall be responsible for the preservation of established reference points and shall make no changes or relocations without the prior written approval of OWNER. CONTRACTOR shall report to ENGINEER whenever any reference point is lost or destroyed or requires relocation because of necessary changes in grades or locations. Reference points destroyed by negligence of CONTRACTOR will be replaced by OWNER at the expense of CONTRACTOR. Construction Staking will be furnished by OWNER as provided in Division 01 of the Specifications.

4.06 Constituents of Concern

- A. OWNER shall be responsible for any Constituents of Concern uncovered or revealed at the Site which was not shown or indicated in Plans or Specifications or identified in the Contract Documents to be within the scope of the Work and which may present a substantial danger to persons or property exposed thereto in connection with the Work at the Site. OWNER shall not be responsible for any such materials brought to the Site by CONTRACTOR, Subcontractor, Suppliers or anyone else for whom CONTRACTOR is responsible.
- B. Upon discovering any such material, CONTRACTOR shall immediately:
 - 1. stop all Work in connection with such Hazardous Environmental Condition and in any area affected thereby (except in emergency as required by paragraph 6.18), and
 - 2. notify OWNER and ENGINEER (and thereafter confirm such notice in writing). OWNER shall promptly consult with ENGINEER concerning the necessity for OWNER to retain a qualified expert to evaluate such Hazardous Environmental Condition or take corrective action, if any.
- C. CONTRACTOR shall not be required to resume Work in connection with such Hazardous Environmental Condition or in any such affected areas until after OWNER has obtained any required permits related thereto and delivered to CONTRACTOR special written notice:
 - 1. specifying that such condition and any affected area is or has been rendered safe for the resumption of Work, or
 - 2. specifying any special conditions under which such Work may be resumed safely.
- D. If OWNER and CONTRACTOR cannot agree as to entitlement to, or the amount, or extent of an adjustment, if any, in Contract Price or Contract Terms as a result of such Work stoppage or such special conditions under which Work is agreed by CONTRACTOR to be resumed, either party may make a Claim therefor as provided in paragraph 11.01.
- E. If after receipt of such special written notice CONTRACTOR does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then OWNER may order such portion of the Work that is in connection with such condition, or in such affected area, to be deleted from the Work. If OWNER and CONTRACTOR cannot agree as to entitlement to, or the amount, or extent of an adjustment, if any, in Contract Price or Contract Time as a result of deleting such portion of the Work, then either party may make a Claim therefor as provided in paragraph 11.01.

OWNER may have such deleted portion of the Work performed by OWNER's own forces or others in accordance with paragraph 7.01.

- F. To the fullest extent permitted by Laws and Regulations, OWNER shall indemnify and hold harmless CONTRACTOR, Subcontractors, ENGINEER, ENGINEER's Consultants and the officers, directors, employees, agents, other consultants and subcontractors of each and any of them from and against all claims, costs, losses, damages and expenses arising out of or resulting from such condition per this paragraph 4.06, provided that:
 - 1. any such claim, cost, loss or damage is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom, and
 - 2. nothing in this paragraph 4.06 shall obligate OWNER to indemnify any person or entity from and against the consequences of that person's or entity's own negligence.
- G. The provisions of paragraph 4.03 are not intended to apply to the presence of Constituents of Concern or Hazardous Environmental Conditions uncovered or revealed at the Site.

Article 5 Bonds and Insurance

5.01 Performance and Other Bonds

- A. CONTRACTOR shall furnish performance and payment Bonds, on the form included in the Contract Documents, each in an amount at least equal to the Contract Price, as security for the faithful performance and payment of all of CONTRACTOR's obligations under the Contract Documents. These Bonds shall remain in effect at least until 1 year after the date when final payment becomes due, except as otherwise provided by Laws and Regulations or as specified in the Contract Documents or Bond. CONTRACTOR shall also furnish such other Bonds as are required by the Supplementary Conditions.
- B. All Bonds shall be in the forms prescribed by the Contract Documents and be executed by such Sureties as
 - 1. are licensed to conduct business in the state where the Project is located, and
 - 2. are named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the U.S. Department of Treasury, Financial Management Service, Surety Bond Branch.
- C. All Bonds signed by an agent must be accompanied by a certified copy of such agent's authority to act.
- D. If Surety on any Bond furnished by CONTRACTOR is declared as bankrupt or becomes insolvent, or its right to do business is terminated in any state where any part of the Project is located, or it ceases to meet the requirements of clauses (1) and (2) of paragraph 5.01, CONTRACTOR shall within 5 days thereafter substitute another Bond and Surety, both of which shall be acceptable to OWNER.

5.02 Licensed Insurers and Sureties

- A. Bonds and insurance required by the Contract Documents to be purchased and maintained by OWNER or CONTRACTOR shall be obtained from surety or insurance companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue Bonds or insurance policies for the limits and coverages so required.

5.03 Insurance

- A. CONTRACTOR shall purchase and maintain during the term of the Project such insurance as will protect him, OWNER(s) and ENGINEER(s) from Claims arising out of the Work described in this Contract and performed by CONTRACTOR, Subcontractor(s) or Sub subcontractor(s) consisting of:
 - 1. Workers' Compensation Insurance including Employer's Liability to cover employee injuries or disease compensable under the Workers' Compensation Statutes of the states in which Work is conducted under this Contract; disability benefit laws, if any; or Federal compensation acts such as U.S. Longshoremen or Harbor Workers', Maritime Employment, or Railroad Compensation Act(s), if applicable. Self-insurance plans approved by the regulatory authorities in the state in which Work on this Project is performed are acceptable.
 - 2. An occurrence form Commercial General Liability policy to cover bodily injury to persons other than employees and for damage to tangible property, including loss of use thereof, plus appropriate endorsements to protect OWNER and ENGINEER against Claims, demands, and lawsuits from employees of CONTRACTOR and Subcontractors, including the following exposures:
 - a. All premises and operations.
 - b. Explosion, collapse and underground damage.
 - c. CONTRACTOR's Protective coverage for independent contractors or Subcontractors employed by him.
 - d. Broad form blanket, contractual liability for the obligation assumed in the Indemnification or Hold Harmless agreement found in the General Conditions or Supplementary Conditions of this Contract.
 - e. Personal Injury Liability endorsement with no exclusions pertaining to employment.
 - f. Products and Completed Operations coverage. Coverage shall extend through the Contract guarantee period.
 - g. Broad form property damage.
 - h. Cross liability endorsement.
 - i. For design professional additional insureds, ISO Endorsement CG 20 32 04 13, "Additional Insured-Engineers, Architects or Surveyors Not Engaged by the Named Insured" or its equivalent.

3. Comprehensive Automobile Liability policy to cover bodily injury and property damage arising out of the ownership, maintenance or use of any motor vehicle, including owned, non-owned and hired vehicles. Comprehensive General Liability and the Comprehensive Auto Liability shall be written by the same insurance carrier, though not necessarily in one policy.
4. CONTRACTOR shall purchase for OWNER an Owner's Protective Liability policy to protect OWNER, ENGINEER, their consultants, agents, employees and such public corporations in whose jurisdiction the Work is located for their liability for Work performed by the CONTRACTOR, the Subcontractor(s) or the Sub subcontractor(s) under this Contract.
5. When a limit of liability is identified in the Supplementary Conditions, CONTRACTOR shall purchase a Builder's Risk Installation Floater in a form acceptable to OWNER covering property of the Project for the full cost of replacement as of the time of any loss which shall include, as named insureds,
 - a. CONTRACTOR,
 - b. all Subcontractors,
 - c. all Sub subcontractors,
 - d. OWNER, and ENGINEER(s) or Architect(s), as their respective interests may prove to be at the time of loss, covering insurable property which is the subject of this Contract, whether in place, stored at the Site, stored elsewhere, or in transit at the risk of the insured(s).

Coverage shall be effected on an "All Risk" form including, but not limited to, the perils of fire, wind, vandalism, collapse, theft, flood and earthquake, with removal of passive design error exclusion. Except as may otherwise be required by OWNER, CONTRACTOR may arrange for such deductibles as CONTRACTOR deems to be within CONTRACTOR's ability to self-assume, but CONTRACTOR will be held solely responsible for the amount of such deductible and for any co-insurance penalties. Any insured loss shall be adjusted with OWNER and CONTRACTOR and paid to OWNER and CONTRACTOR as Trustee for the other insureds.

6. Umbrella or Excess Liability
 - a. The CONTRACTOR is granted the option of arranging coverage under a single policy for the full limit required or by a combination of underlying policies with the balance provided by an Excess or Umbrella Liability policy equal to the total limit(s) requested. Umbrella or Excess policy wording shall be at least as broad as the primary or underlying policy(ies) and shall apply both to CONTRACTOR's General Liability and Automobile Liability Insurance and shall be written on an occurrence basis.
7. Railroad Protective Liability
 - a. Where any of the Work is within a railroad right-of-way or where a limit of liability is identified in the Supplementary Conditions, CONTRACTOR will provide coverage in the name of each railroad company having jurisdiction over rights of way across which

Work under the Contract is to be performed. The form of policy and the limits of liability shall be determined by the railroad company(ies) involved. See the Supplementary Conditions for limits and coverage requested.

8. CONTRACTOR's Professional Liability Insurance

- a. If CONTRACTOR will provide or furnish professional services under this Contract through a delegation of professional design services or otherwise, then CONTRACTOR shall be responsible for purchasing and maintaining applicable professional liability insurance. This insurance shall provide protection against Claims arising out of performance of professional design or related services caused by a negligent error, omission, or act for which the insured party is legally liable. It shall be maintained throughout the duration of the Contract and for a minimum of two years after Substantial Completion. If such professional design services are performed by a Subcontractor, and not by CONTRACTOR itself, then the requirements of this paragraph may be satisfied through the purchasing and maintenance of such insurance by such Subcontractor.

B. OWNER's responsibilities in respect of purchasing and maintaining insurance are set forth below:

1. OWNER shall assume responsibility for such boiler and machinery insurance as may be required or considered to be necessary by OWNER in the course of construction, testing or after completion.
 - a. OWNER shall assume responsibility for such insurance as will protect the OWNER against any loss of use of OWNER's property due to those perils insured pursuant to paragraph 1 above.

5.04 Limits of Liability

- A. The required limits of liability for insurance coverages required in paragraphs 5.03 shall be not less than those specified in the Supplementary Conditions.

5.05 Notice of Cancellation or Intent Not to Renew

- A. Policies will be endorsed to provide that at least 30 days written notice shall be given to OWNER and to ENGINEER of cancellation, intent not to renew, or material modification of the coverage.

5.06 Evidence of Coverage

- A. Prior to commencement of the Work, CONTRACTOR shall furnish to OWNER and ENGINEER, Certificates of Insurance in force on current Accord® Certificate of Insurance form. Other forms of Certificate are acceptable only if;
 1. they include all of the items prescribed in the current Accord® Certificate of Insurance form, including agreement to cancellation provisions outlined in paragraph 5.05 above; and
 2. they have approval of OWNER and ENGINEER.

- B. Prior to the commencement of the Work, CONTRACTOR shall furnish to OWNER complete "originally signed" copies of the Owner's Protective Liability Policy. The number of copies shall be the same as the number of counterparts of the Agreement. OWNER reserves the right to request complete copies of other policies if deemed necessary to ascertain details of coverage not provided by the certificates. Such policy copies shall be "Originally Signed Copies," and so designated.

5.07 Qualification of Insurers

- A. In order to determine financial strength and reputation of insurance carriers, all companies providing the coverages required shall be licensed or approved by the Insurance Bureau of the state in which the Project is located and shall have a financial rating not lower than XI and a policyholder's service rating no lower than B+ as listed in A.M. Best's Key Rating Guide, current edition. Companies with ratings lower than B+:XI will be acceptable only upon written consent of OWNER.

5.08 Damage Claims - Acknowledgment and Reports

- A. CONTRACTOR shall furnish to OWNER an acknowledgment receipt from the insurance carrier for each damage claim against the Project. The receipt shall include the insurance carrier's assigned claim number.
- B. Upon request, CONTRACTOR or his insurance carrier shall also furnish to OWNER a status report on all damage claims. This report shall include inspections made, the disposition of claims, and what action has been taken towards settlement of each claim.
- C. Failure of CONTRACTOR to comply with this paragraph 5.08 may result in the amount of such damage claims being withheld from CONTRACTOR's monthly pay estimate. Such withholding shall be reimbursed in the monthly pay estimate following compliance with this paragraph.

5.09 Cost of Insurance

- A. The unit cost of the insurance herein specified will not be a specific bid item, but the cost of such insurance will be included by the CONTRACTOR in the various prices bid.

5.10 Waiver of Rights

- A. OWNER and CONTRACTOR intend that all policies purchased in accordance with paragraph 5.03 will protect OWNER, CONTRACTOR, Subcontractors, ENGINEER, ENGINEER's Consultants (and all other persons or entities identified in the Supplementary General Conditions to be listed as insureds or additional insureds in such policies) and will provide primary coverage for all losses and damages caused by the perils covered thereby. Such policies shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any of the insureds or additional insureds thereunder.
- B. OWNER and CONTRACTOR waive all rights against each other and their respective officers, directors, employees and agents for all losses and damages caused by, arising out of or resulting from any of the perils covered by such policies and any other property insurance applicable to the Work; and in addition, waive all such rights against Subcontractors, ENGINEER, ENGINEER's Consultants and any other persons or entities identified in the Supplementary

General Conditions to be listed as insureds or additional insureds under such policies for loss and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by OWNER as trustee or otherwise payable under any policy so issued.

5.11 Receipt and Application of Insurance Proceeds

- A. Any insured loss under the policies of insurance required by paragraph 5.03.A.5 will be adjusted with OWNER and made payable to OWNER as fiduciary for the insureds, as their interests may appear, subject to the requirements of any applicable mortgage clause. If no other special agreement is reached the damaged Work shall be repaired or replaced, the monies so received applied on account thereof, and the Work and the cost thereof covered by an appropriate Change Order, Field Order or Work Change Directive.
- B. OWNER as fiduciary shall have power to adjust and settle any loss under the policies required by paragraph 5.03.A.5 with the insurers unless one of the parties in interest shall object in writing within fifteen days after the occurrence of loss to OWNER's exercise of this power. If such objection be made, OWNER as fiduciary shall make settlement with the insurers in accordance with such agreement as the parties in interest may reach. If no such agreement among the parties in interest is reached, OWNER as fiduciary shall adjust and settle the loss with the insurers.

Article 6 CONTRACTOR's Responsibilities

6.01 Supervision and Superintendence

- A. CONTRACTOR shall supervise and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. CONTRACTOR shall be solely responsible for the means, methods, techniques, sequences and procedures of construction. CONTRACTOR shall be responsible to see that the finished Work complies with the Contract Documents. However, if specific means, methods, techniques, sequences and procedures of construction are prescribed in the Plans or Specifications, CONTRACTOR shall be responsible to comply therewith, but may implement such prescribed Work in a manner of CONTRACTOR's choosing so long as the Work complies with the requirements of the Plans and Specifications.
- B. At all times during the progress of the Work, CONTRACTOR shall assign and maintain a competent superintendent who shall not be replaced without written notice to OWNER and ENGINEER except under extraordinary circumstances. Any superintendent or foreman who neglects to have Work done in accordance with the Plans and Specifications shall be removed from the Project. The superintendent will be CONTRACTOR's representative at the Site and shall have authority to act on behalf of CONTRACTOR. All communications given to the superintendent shall be as binding as if given to CONTRACTOR.

6.02 Labor and Working Hours

- A. CONTRACTOR shall provide competent, suitably qualified personnel in their various duties. CONTRACTOR shall at all times maintain good discipline and order at the Site. Except as otherwise required for the safety or protection of persons, the Work, property at the Site or adjacent thereto, and except as otherwise indicated in the Contract Documents, all Work at the Site shall be

performed during regular working hours (7:00 a.m. to 7:00 p.m.), and CONTRACTOR will not permit the performance of Work on Sunday or any legal holiday without OWNER's written consent given after prior written notice to ENGINEER.

6.03 Services, Materials and Equipment

- A. Unless otherwise specified in the Contract Documents, CONTRACTOR shall furnish and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities and all other facilities and incidentals necessary for the furnishing, performance, testing, start up and completion of the Work.
- B. All materials and equipment shall be of good quality and new, except as otherwise provided in the Contract Documents. All warranties and guarantees specifically called for by the Contract Documents shall expressly run to the benefit of OWNER. If required by ENGINEER, CONTRACTOR shall furnish satisfactory evidence, (including reports of required tests) as to the kind and quality of materials and equipment to be incorporated in the Work. The CONTRACTOR shall not use material in the Work until Shop Drawing or Submittals have been reviewed by the ENGINEER. All materials which do not meet the requirements of the Specifications at the time they are to be used will be rejected, and unless otherwise permitted by ENGINEER, shall be plainly marked and removed immediately from the Work.
- C. All materials and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned in accordance with the instructions of the applicable manufacturer, fabricator, Supplier or distributor, except as otherwise provided in the Contract Documents.

6.04 Substitutes and "Or-Equals"

- A. Whenever an item of materials or equipment is specified or described in the Contract Documents for installation in the Work by using the name of a proprietary item or the name of a particular manufacturer, fabricator, supplier or distributor; or means, methods, techniques, sequences and procedures of construction are prescribed in the Plans or Specifications; the specification or description is intended to establish the type, function and quality required or the means, methods, techniques, sequences and procedures of construction required. Unless the specification or description contains or is followed by words indicating that no like, equivalent or "or-equal" item or no substitution is permitted, other items of material or equipment or materials or equipment of other manufacturers, fabricators, suppliers or distributors; or other means, methods, techniques, sequences and procedures of construction may be accepted by ENGINEER under the following circumstances:
 - 1. "Or-Equal": If in ENGINEER's sole discretion an item of material or equipment proposed by CONTRACTOR is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by ENGINEER as an "or-equal" item, in which case review and approval of the proposed item may, in ENGINEER's sole discretion, be accomplished without compliance with some or all of the requirements for acceptance of proposed substitute items.

2. Substitute Items: If in ENGINEER's sole discretion an item of material or equipment proposed by CONTRACTOR does not qualify as an "or-equal" item under paragraph 6.04.A; or a proposed means, methods, techniques, sequences and procedures of construction are different from what is prescribed in the Plans or Specifications, it will be considered a proposed substitute item.
- B. CONTRACTOR shall submit sufficient information as provided below to allow ENGINEER to determine that the item of material or equipment or means, methods, techniques, sequences and/or procedures proposed is essentially equivalent to that named and an acceptable substitute therefor. The procedure for review by the ENGINEER will include the following, as supplemented in the Specifications, and as ENGINEER may decide is appropriate under the circumstances. Requests for review of substitute items of material and equipment will not be accepted by ENGINEER from anyone other than CONTRACTOR.
 - C. If CONTRACTOR wishes to furnish or use a substitute, CONTRACTOR shall make written application to ENGINEER on the Substitution Request Form provided for acceptance thereof, certifying that the proposed substitute will:
 1. perform adequately the functions and achieve the results called for by the general design,
 2. be similar in substance to that specified,
 3. and be suited to the same use and capable of performing the same function as that specified.

The application will state the extent, if any, to which the evaluation and acceptance of the proposed substitute will prejudice CONTRACTOR's achievement of Substantial Completion on time, whether or not acceptance of the proposed substitute for use in the Work will require a change in the Contract Documents (or in the provisions of any other direct contract with OWNER for work on the Project) to adapt the design to the proposed substitute, and whether or not incorporation or use of the substitute in connection with the Work is subject to payment of any license fee or royalty.

- D. All variations of the proposed substitute from that specified shall be identified in the application and available maintenance, repair and replacement service shall be indicated. The application shall also contain an itemized estimate of all costs or credits that will result directly or indirectly from acceptance of such substitute, including costs of redesign and claims of other contractors affected by the resulting change, all of which shall be considered by ENGINEER in evaluating the proposed substitute. ENGINEER may require CONTRACTOR to furnish additional data about the proposed substitute.
- E. All data to be provided by CONTRACTOR in support of any proposed "or-equal" or substitute item will be at CONTRACTOR's expense. ENGINEER will be the sole judge of acceptability, and ENGINEER's determination shall be final and binding, may not be reversed through an appeal under any provisions of the Contract Documents, and no "or-equal" or substitute shall be ordered, installed or utilized without ENGINEER's prior written acceptance. OWNER may require CONTRACTOR to furnish at CONTRACTOR's expense a special performance guarantee or other surety with respect to any "or-equal" or substitute which has been approved by ENGINEER.

- F. ENGINEER will record time required by ENGINEER and ENGINEER's consultants in evaluating substitutions proposed by CONTRACTOR and in making changes in the Contract Documents occasioned thereby. Whether or not ENGINEER accepts a proposed substitute, CONTRACTOR shall reimburse OWNER for the charges of ENGINEER and ENGINEER's consultants for evaluating any proposed substitute and in making any changes in the Contract Documents resulting therefrom.

6.05 Concerning Subcontractors

- A. CONTRACTOR shall not employ any Subcontractor, Supplier or other person or organizations, including those who are to furnish the principal items of materials or equipment, whether initially or as a substitute, against whom OWNER or ENGINEER may have reasonable objection. CONTRACTOR shall furnish ENGINEER a complete list of any Subcontractor, Supplier or other person or organization furnishing principal items of material or equipment within 4 days of request. Failure to object to any Subcontractor, Supplier, other person or organization by OWNER or ENGINEER shall not constitute a waiver of any right of OWNER or ENGINEER to reject defective Work.
- B. If OWNER or ENGINEER, after due investigation, has reasonable objection to any Subcontractor, Supplier, other person or organization proposed by CONTRACTOR after the Notice of Award, CONTRACTOR shall submit an acceptable substitute and the Contract Price shall be increased or decreased by the difference in cost occasioned by such substitution, and an appropriate Change Order shall be issued. CONTRACTOR shall not be required to employ any Subcontractor, Supplier, other person or organization against whom CONTRACTOR has reasonable objection.
- C. The CONTRACTOR shall not award Work to Subcontractor(s), in excess of 50% of the Contract Price, without prior written approval of the OWNER.
- D. CONTRACTOR shall be fully responsible for all acts and omissions of his Subcontractors, Suppliers and of persons and organizations performing or furnishing any of the Work under a direct or indirect contract with CONTRACTOR just as CONTRACTOR is responsible for CONTRACTOR's own acts and omissions. Nothing in the Contract Documents shall create for the benefit of any such Subcontractor, Supplier or other person or organization any contractual relationship between OWNER or ENGINEER and any such Subcontractor, Supplier or other person or organization, nor shall it create any obligation on the part of OWNER or ENGINEER to pay or to see to the payment of any moneys due any Subcontractor, Supplier or other person or organization. OWNER or ENGINEER may furnish to any Subcontractor, Supplier or other person or organization, to the extent practicable, evidence of amounts paid to CONTRACTOR on account of specific Work done.
- E. The CONTRACTOR shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers and other persons and organizations performing or furnishing any of the Work under a direct or indirect contract with CONTRACTOR. CONTRACTOR shall require all Subcontractors, Suppliers and such other persons and organizations performing or furnishing any of the Work to communicate with the ENGINEER through CONTRACTOR.
- F. If the amount of the subcontract or the nature of the Work to be performed thereunder warrants, OWNER may require Subcontractor to furnish, for the benefit of the OWNER and CONTRACTOR jointly, Bonds in an amount proportioned to the amount of his subcontract, and for the same purpose and under the same specifications as those of the general Contract. The Surety on the general Contract shall not be eligible to furnish such Subcontract Bonds.

- G. All Work performed for CONTRACTOR by a Subcontractor or Supplier will be pursuant to an appropriate agreement between CONTRACTOR and the Subcontractor or Supplier which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of OWNER and ENGINEER. Whenever any such agreement is with a Subcontractor or Supplier who is listed as and additional insured on the property insurance provided in paragraph 5.03.A.5, the agreement between the CONTRACTOR and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against OWNER, CONTRACTOR, ENGINEER, ENGINEER's Consultants and all other additional insureds for all losses and damages caused by, arising out of or resulting from any of the perils covered by such policies and any other property insurance applicable to the Work. If the insurers on any such policies require separate waiver forms to be signed by any Subcontractor or Supplier, CONTRACTOR will obtain the same. CONTRACTOR shall file a true copy of such agreement with OWNER.

6.06 Patent Fees and Royalties

- A. CONTRACTOR shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product or device is specified in the Contract Documents for use in the performance of the Work and if to the actual knowledge of OWNER or ENGINEER its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by OWNER in Contract Documents.
- B. To the fullest extent permitted by Laws and Regulations, CONTRACTOR shall defend, indemnify and hold harmless OWNER and ENGINEER and anyone directly or indirectly employed by either of them from and against all claims, costs, losses, damages and expenses arising out of or resulting from any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product or device not specified in the Contract Documents, and shall defend all such claims in connection with any alleged infringement of such rights.

6.07 Permits and Licenses

- A. CONTRACTOR shall obtain and pay for all construction permits and licenses. OWNER shall assist CONTRACTOR, when necessary, in obtaining such permits and licenses. CONTRACTOR shall pay all governmental charges, permit, review, and inspection fees necessary for the prosecution of the Work, which are applicable at the time of opening of Bids, or, if there are no Bids, on the Effective Date of the Agreement. CONTRACTOR shall pay all charges of utility owners for connections to the Work.

6.08 Laws and Regulations

- A. CONTRACTOR shall give all notices and comply with all laws, ordinances, rules, and regulations applicable to furnishing and performance of the Work. Neither OWNER nor ENGINEER shall be responsible for monitoring CONTRACTOR's compliance with any Laws, ordinances, rules, and Regulations.

- B. If CONTRACTOR performs any Work that is contrary to such laws, ordinances, rules and regulations, CONTRACTOR shall bear all claims, costs, losses, damages and expenses caused by, arising out of, or resulting therefrom. However, it shall not be CONTRACTOR's primary responsibility to make certain that the Specifications and Plans are in accordance with such laws, ordinances, rules, and regulations, but this shall not relieve CONTRACTOR of CONTRACTOR's obligations under paragraph 3.03.
- C. OWNER or CONTRACTOR may give notice to the other party of any changes after the submission of CONTRACTOR's Bid (or after the date when CONTRACTOR became bound under a negotiated Contract) in Laws or Regulations having an effect on the cost or time of performance of the Work, including but not limited to changes in Laws or Regulations having an effect on procuring permits and on sales, use, value-added, consumption, and other similar taxes. If OWNER and CONTRACTOR are unable to agree on entitlement to, or on the amount, or extent, if any, of any adjustment in Contract Price or Contract Times resulting from such changes, then within 30 days of such notice CONTRACTOR may submit a Change Proposal, or OWNER may initiate a Claim.

6.09 Taxes

- A. CONTRACTOR shall pay all sales, consumer, use and other similar taxes required to be paid by CONTRACTOR in accordance with Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

6.10 Use of Premises

- A. CONTRACTOR shall confine construction equipment, the storage of materials and equipment and the operations of workers to the Project Site and land and areas identified in and permitted by the Contract Documents and other land and areas permitted by Laws and Regulations, rights of way, permits and easements, and shall not unreasonably encumber the premises with construction equipment or other materials or equipment. CONTRACTOR shall assume full responsibility for any damage to any such land or area or to the owner or occupant thereof or of any adjacent land or areas resulting from the performance of the Work. Should any claim be made by any such owner or occupant because of the performance of the Work, CONTRACTOR shall promptly settle with any such other party by negotiation or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law. CONTRACTOR's continuing obligations under paragraph 6.24 shall be applicable to any claim hereunder.

6.11 Removal of Debris and Cleaning

- A. During the progress of the Work, CONTRACTOR shall keep the premises free from accumulations of waste materials, rubbish and other debris resulting from the Work. At the completion of the Work CONTRACTOR shall remove all waste materials, rubbish and debris from and about the premises as well as all tools, appliances, construction equipment and machinery, and surplus materials, and shall leave the Site clean and ready for occupancy by OWNER at Substantial Completion of the Work. CONTRACTOR shall restore to their original condition all property not designated for alteration by the Contract Documents. If CONTRACTOR shall fail to keep the above noted areas cleaned of dust or debris resulting from CONTRACTOR's operations, CONTRACTOR shall be so notified in writing by ENGINEER. If within 24 hours after receipt of such notice CONTRACTOR shall fail to clean such areas satisfactorily, OWNER may have such other agency as he shall designate, perform the work and all costs of such cleaning shall be paid for by CONTRACTOR.

6.12 Loading Structures

- A. CONTRACTOR shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall CONTRACTOR subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

6.13 Protection of Utilities

- A. When it is possible for construction operations to endanger any public or private utility, conduit, or structure, CONTRACTOR shall notify the utility owner of this possibility, and safeguard and support such utilities, conduits, or structures. Where it is the policy of any utility owner to make its own repairs to damaged conduit or other structures, CONTRACTOR shall cooperate to the fullest extent with the utility, and he shall see that his operations interfere as little as possible with these operations, and CONTRACTOR shall assume the cost of any charge against OWNER therefor. In cases where existing Utilities or Utility service connections are encountered, CONTRACTOR shall perform his operations in such a manner that service will be uninterrupted, and the cost thereof shall be at CONTRACTOR's expense, unless otherwise provided.

6.14 Record Documents

- A. CONTRACTOR shall maintain in a safe place at the Site 1 record copy of all Specifications, Plans, Addenda, Change Orders, Work Change Directives, and Field Orders, in good order and annotated to show all changes made during construction. These record documents together with all Samples and all Shop Drawings shall be available to ENGINEER for examination and shall be delivered to ENGINEER for OWNER upon completion of the Work.

6.15 Safety and Protection

- A. CONTRACTOR shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. CONTRACTOR shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:
 - 1. all persons on the Work Site or who may be affected by the Work,
 - 2. all the Work and materials or equipment to be incorporated therein, whether in storage on or off the Site, and
 - 3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, and Utilities and not designated for removal, relocation or replacement in the course of construction.
- B. CONTRACTOR shall comply with all applicable Laws and Regulations and orders of any public body having jurisdiction for the safety of persons or property or to protect them from damage, injury or loss; and shall erect and maintain all necessary safeguards for such safety and protection. CONTRACTOR shall notify owners of adjacent property, Utilities, and utility owners when prosecution of the Work may affect them.
- C. CONTRACTOR shall restore, at his own expense, any public or private property damaged or injured in consequence of any act or omission on his part, or on the part of his employees or agents, to a condition equal or better than that existing before such injury or damage was done. If CONTRACTOR neglects to restore or make good such damages or injury, OWNER may, upon 48 hours' notice, proceed

to restore or make good such damage or injury and to order the cost thereof deducted from any monies that are due, or may become due, to CONTRACTOR for this Work.

- D. CONTRACTOR's duties and responsibilities for the safety and protection of the Work shall continue until such time as all the Work is completed and ENGINEER has issued a notice to OWNER and CONTRACTOR in accordance with paragraph 14.11 that the Work is Acceptable.
- E. CONTRACTOR shall comply with the applicable requirements of OWNER's safety programs, if any. Any OWNER's safety programs that are applicable to the Work are identified or included in the Supplementary Conditions or Specifications.
- F. CONTRACTOR shall inform OWNER and ENGINEER of the specific requirements of CONTRACTOR's safety program with which OWNER's and ENGINEER's employees and representatives must comply while at the Site.
- G. CONTRACTOR's duties and responsibilities for safety and protection will continue until all the Work is completed, ENGINEER has issued a written notice to OWNER and CONTRACTOR in accordance with paragraph 14.11 that the Work is acceptable, and CONTRACTOR has left the Site (except as otherwise expressly provided in connection with Substantial Completion).
- H. CONTRACTOR's duties and responsibilities for safety and protection will resume whenever CONTRACTOR or any Subcontractor or Supplier returns to the Site to fulfill warranty or correction obligations, or to conduct other tasks arising from the Contract Documents.

6.16 Safety Representative

- A. CONTRACTOR shall be responsible to designate for itself and its employees, and its Subcontractors a qualified and experienced safety representative at the Site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

6.17 Hazard Communication Program

- A. CONTRACTOR shall be responsible for coordinating any exchange of safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with applicable Laws or Regulations.

6.18 Emergencies

- A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, CONTRACTOR, without special instruction or authorization from OWNER or ENGINEER, is obligated to act to prevent threatened damage, injury or loss. CONTRACTOR shall give ENGINEER prompt written notice if CONTRACTOR believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby. If ENGINEER determines that a change in the Contract Documents is required because of the action taken by CONTRACTOR in response to such an emergency, a Work Change Directive or Change Order will be issued to document the consequences of such action.

6.19 Shop Drawings and Samples

- A. CONTRACTOR shall submit Shop Drawings required by the Contract Documents to ENGINEER for review, in accordance with an accepted schedule. All Submittals will be identified as ENGINEER may require and in the number of copies specified in the Specifications. The data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials and similar data to show ENGINEER the materials and equipment CONTRACTOR proposes to provide and to enable ENGINEER to review the information for the limited purposes required by paragraph 6.21.
- B. CONTRACTOR shall also submit all samples required by the Contract Documents to ENGINEER for review in accordance with an accepted schedule. Each Sample will be identified clearly as to material, Supplier, pertinent data such as catalog numbers, the use for which intended, and other data as ENGINEER may require to enable ENGINEER to review the Submittal for the limited purposes required by paragraph 6.21. The number of each sample to be submitted will be as specified in the Specifications.

6.20 Submittal Procedures

- A. Before submitting each Shop Drawing or Sample, CONTRACTOR shall have determined and verified:
 - 1. all field measurements, quantities, dimension, specified performance criteria, installation requirements, manufacturer's recommendations, material, catalog numbers and similar information with respect thereto,
 - 2. all materials with respect to intended use, fabrication, shipping, handling, storage, assembly and installation pertaining to the performance of the Work, and
 - 3. all information relative to CONTRACTOR's responsibilities in respect of means, methods, techniques, sequences and procedures of construction and safety precautions and programs incident thereto.
- B. CONTRACTOR shall have reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents.
- C. Each Submittal will bear a stamp or specific written indication that CONTRACTOR has satisfied CONTRACTOR's obligations under the Contract Documents with respect to review and approval of that Submittal.
- D. At the time of each submission, CONTRACTOR shall in writing call ENGINEER's attention to any deviations that the Shop Drawings or Samples may have from the requirements of the Contract Documents. This notice shall be both a written communication separate from the Shop Drawing's or Sample submittal; and, in addition, by a specific notation made on each Shop Drawing or Sample submitted to ENGINEER for review of each such variation.
- E. CONTRACTOR shall make corrections required by ENGINEER and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review. CONTRACTOR shall direct specific attention in writing to revisions other than the corrections called for by ENGINEER on previous Submittals.

- F. CONTRACTOR shall furnish required Submittals with sufficient information and accuracy to obtain required approval of an item with no more than three submittals. ENGINEER will record ENGINEER's time for reviewing a fourth or subsequent submittal of Shop Drawings, sample, or other item requiring approval, and CONTRACTOR shall be responsible for ENGINEER's charges to OWNER for such time. OWNER may impose a set-off against payments due to CONTRACTOR to secure reimbursement for such charges.
- G. If CONTRACTOR requests a change of a previously approved Submittal item, CONTRACTOR shall be responsible for ENGINEER's charges to OWNER for its review time, and OWNER may impose a set-off against payments due to CONTRACTOR to secure reimbursement for such charges, unless the need for such change is beyond the control of CONTRACTOR.

6.21 ENGINEER's Review

- A. ENGINEER will review Shop Drawings and Samples in accordance with the Schedule of Submittals accepted by ENGINEER as required by paragraph 2.05. ENGINEER's review shall be only for conformance with the design concept of the Project and for compliance with the information given in the Contract Documents and shall not extend to means, methods, sequences, techniques or procedures of construction or to safety precautions or programs incident thereto. The review of a separate item as such will not indicate review of the assembly in which the item functions.
- B. ENGINEER's review of Shop Drawings or samples shall not relieve CONTRACTOR from responsibility for any variations from the Contract Documents unless CONTRACTOR has in writing called ENGINEER's attention to such variation at the time of submission and ENGINEER has given written concurrence to the specific variation, nor shall any concurrence by ENGINEER relieve CONTRACTOR from responsibility for errors or omissions in the Shop Drawings. ENGINEER's review shall not relieve CONTRACTOR from responsibility for complying with the requirements of paragraph 6.20.
- C. Where a Shop Drawing or sample is required by the Contract Documents or the Schedule of Submittals accepted by ENGINEER per paragraph 2.05, no related Work shall be commenced until the Submittal has been reviewed by the ENGINEER.

6.22 Continuing the Work

- A. CONTRACTOR shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with OWNER. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as CONTRACTOR and OWNER may otherwise agree in writing.

6.23 CONTRACTOR's General Warranty and Guarantee

- A. CONTRACTOR warrants and guarantees to OWNER, ENGINEER, and ENGINEER's Consultants that all work will be in accordance with the Contract Documents and will not be defective. CONTRACTOR's warranty and guarantee excludes defects or damage caused by:
 - 1. abuse, modification, or improper maintenance or operation by persons other than CONTRACTOR, Subcontractors, Suppliers, or their employees, agents, or representatives, or any person or entity for whom CONTRACTOR is responsible; or
 - 2. normal wear and tear under normal usage.

- B. CONTRACTOR's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of CONTRACTOR's obligation to perform the Work in accordance with the Contract Documents:
1. observations by ENGINEER;
 2. recommendation of any progress or final payment by ENGINEER;
 3. the issuance of a certificate of Substantial Completion or any payment by OWNER to CONTRACTOR under the Contract Documents;
 4. use or occupancy of any part of the Work by OWNER;
 5. any acceptance by OWNER or failure to do so;
 6. any review or approval of a Shop Drawing or Sample Submittal or the issuance of a notice of acceptability by ENGINEER per paragraph 14.11;
 7. any inspection, test or approval by others; or
 8. any correction of defective Work by OWNER.
- C. If Contract requires the CONTRACTOR to accept the assignment of a contract entered into by OWNER, then the specific warranties, guarantees, and correction obligations contained in the assigned contract shall govern with respect to CONTRACTOR's performance obligations to OWNER for the Work described in the assigned Contract.
- D. CONTRACTOR shall assign to OWNER all warranties extended to CONTRACTOR by material Suppliers and Subcontractors. If an assignment of warranty requires the material Supplier or Subcontractor to consent to same, then CONTRACTOR shall secure the material Supplier's or Subcontractor's consent to assign said warranties to OWNER.
- E. The warranties provided in this section shall be in addition to, and not in limitation of, any other warranty or remedy required by law.

6.24 Indemnification

- A. To the fullest extent permitted by law, CONTRACTOR shall indemnify, defend (with counsel acceptable to OWNER) and hold harmless OWNER, ENGINEER and any additional indemnitees identified in the Supplementary Conditions and their respective directors, officers, members, partners, affiliates, employees, agents and successors, from and against any and all liabilities, claims, causes of action, lawsuits, liens, injuries, damages, losses and expenses (collectively "Demands") to the extent caused by, arising out of, resulting from or occurring in connection with:
1. CONTRACTOR's breach of, or failure to comply with, the Agreement, the Contract Documents, or any other contract that it enters into regarding the Work, including any default in performance; or
 2. Personal injury or death to any person (including, but not limited to, CONTRACTOR, CONTRACTOR's employees, Subcontractors, Subcontractors' employees, and material Suppliers) or injury to or destruction of property (including claims for loss of use) caused by, arising out of, resulting from, or in any way connected with

- a. the Work,
 - b. any activity associated with the Work, or
 - c. the operations or acts of commission or omission of CONTRACTOR, CONTRACTOR's employees, Subcontractors, Subcontractors' employees, material suppliers, or anyone for whom CONTRACTOR is legally liable in the performance of Work, whether arising before or after completion of the Work.
- B. To the extent caused by, arising out of, resulting from, or occurring in connection with the provisions of the above paragraph 6.24.A, CONTRACTOR's indemnity obligations under this Agreement shall include, but are not limited to:
 - 1. Indemnity for all damages and judgment interest, all costs and fees, including, but not limited to, all defense costs, expenses and actual attorneys' fees, and all settlement payments relating to, arising out of, resulting from or in any way connected with any demand requiring indemnity by this Agreement;
 - 2. All expenses, including but not limited to, costs, expenses and actual attorneys' fees, incurred in securing and enforcing indemnity from CONTRACTOR if CONTRACTOR fails or refuses promptly to fulfill any of the indemnity obligations under this Agreement;
 - 3. All indemnification obligations imposed upon OWNER or ENGINEER, or both, arising out of or in connection with the Work; and
 - 4. Indemnification for any penalties and/or fines arising or resulting from CONTRACTOR's or any SUBCONTRACTOR's failure to comply with laws and/or regulations applicable to its/their Work.
- C. Contractor's duty to indemnify under Subpart A.2. of Article 6.24 is limited to the negligence of Contractor, Contractor's employees, Subcontractors, Subcontractor's employees, material Suppliers, or anyone for whom Contractor is legally liable in the performance of the Work, whether arising before or after the completion of the Work.
- D. The indemnification rights under this Agreement shall not be construed to negate, abridge, or otherwise reduce any other right or obligations of indemnity which would otherwise exist.
- E. OWNER, at its option, may select counsel to defend any demand brought against it without impairing any obligation of the CONTRACTOR to provide indemnification.
- F. The indemnification provisions under this Agreement shall survive the completion or termination of this Agreement.
- G. In the case of claims by any employee of CONTRACTOR, anyone directly or indirectly employed by CONTRACTOR, or anyone for whose acts CONTRACTOR may be liable, the indemnification obligations under this Agreement shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by or for CONTRACTOR under workers' compensation acts. Such obligations shall not be construed to negate, abridge or reduce other rights or obligations of indemnity that would otherwise exist as to a party or person described in this Agreement.

- H. Indemnification, additional insured and hold harmless obligations of CONTRACTOR and Subcontractor under the Contract Documents shall survive the termination of this Agreement.
- I. CONTRACTOR and Subcontractors will compel their insurance company to waive subrogation against OWNER, all ENGINEERS and all CONTRACTORS and Subcontractors identified as additional insureds in the Contract Documents, including any municipal entity now existing or newly created during the term of the Contract Documents.

6.25 Delegation of Professional Design Services

- A. CONTRACTOR will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out CONTRACTOR's responsibilities for construction means, methods, techniques, sequences or procedures. CONTRACTOR shall not be required to provide professional services in violation of applicable Laws and Regulations.
- B. If professional design services or certifications by a design professional related to systems, materials, equipment, structures, means, methods, techniques or sequences of construction are specifically required of CONTRACTOR by the Contract Documents, OWNER and ENGINEER will specify all performance and design criteria that such services must satisfy. CONTRACTOR shall cause such services or certifications to be provided by a professional properly licensed in the state in which the project is located, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, and other Submittals prepared by such professional. Shop Drawings and other Submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to ENGINEER.
- C. OWNER and ENGINEER shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, or approvals performed by such design professionals.
- D. Pursuant to this paragraph 6.25, ENGINEER's review or approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. ENGINEER's review or approval of Shop Drawings and other Submittals (except design calculations and design drawings) will be only for the purpose stated in paragraph 6.21.
- E. CONTRACTOR shall not be responsible for the adequacy of the performance or design criteria specified by OWNER or ENGINEER.

Article 7 Work by Others

7.01 Related Work at Site

- A. In addition to and apart from the Work under the Contract Documents, the OWNER may perform other work at or adjacent to the Site. Such other work may be performed by OWNER's employees, or through contracts between the OWNER and third parties. OWNER may also arrange to have third-party utility owners perform work on their utilities and facilities at or adjacent to the Site.

- B. If any part of CONTRACTOR's Work depends on proper execution or results upon the work of any such other contractor or utility owner, CONTRACTOR shall inspect and promptly report to ENGINEER in writing any delays, defects or deficiencies in such other work that render it unavailable, or unsuitable for such proper execution and results of CONTRACTOR's Work. CONTRACTOR's failure to so report shall constitute an acceptance of the other work as fit and proper for integration with CONTRACTOR's Work except for latent or non-apparent defects and deficiencies in the other work.
- C. CONTRACTOR shall afford each contractor who is party to such a direct contract, and each utility owner, (and OWNER, if OWNER is performing the additional work with OWNER's employees), proper and safe access to the Site and a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work and shall properly connect and coordinate the Work with theirs. Unless otherwise provided in the Contract Documents, CONTRACTOR shall do all cutting, fitting and patching of CONTRACTOR's Work that may be required to make its several parts come together properly and integrate with such other work. CONTRACTOR shall not endanger any work of others by cutting, excavating or otherwise altering their work and will only cut or alter their work with the written consent of ENGINEER and the others whose work will be affected.
- D. If the performance of additional work by other contractors, utility owner, or OWNER was not noted in the Contract Documents, written notice thereof shall be given to CONTRACTOR prior to starting any such additional work. If CONTRACTOR believes that the performance of such additional work by OWNER or others involves additional expense to CONTRACTOR, or requires an extension of the Contract Time, CONTRACTOR may make a Claim therefor as provided in paragraph 11.01. Claims for delay or inconveniences due to operations of such other parties for work noted in the Contract Documents will not be allowed.

Article 8 OWNER's Responsibilities

8.01 Communication to CONTRACTOR

- A. Except as otherwise provided in these General Conditions, OWNER shall issue all communications to CONTRACTOR through ENGINEER.

8.02 Replacement of ENGINEER

- A. In case of termination of the employment of ENGINEER, OWNER shall appoint an engineer against whom CONTRACTOR makes no reasonable objection, whose status under the Contract Documents shall be that of the former ENGINEER.

8.03 Furnishing Data

- A. OWNER shall furnish the data required of OWNER under the Contract Documents promptly.

8.04 Pay When Due

- A. OWNER shall make payments to CONTRACTOR promptly after they are due as provided in paragraphs 14.05 and 14.11.

8.05 Lands and Easements; Reports and Tests

- A. OWNER's duties in respect to providing lands and easements and providing engineering surveys to establish reference points are set forth in paragraphs 4.01 and 4.05. Paragraph 4.02 refers to OWNER's identifying and making available to CONTRACTOR copies of reports of investigations and tests of subsurface and latent physical conditions at the Site.

8.06 Change Orders

- A. In connection with OWNER's rights to request changes in the Work in accordance with Article 10, OWNER (especially in certain instances as provided in paragraph 10.01) is obligated to execute Change Orders.

8.07 Inspections, Tests, and Approvals

- A. OWNER'S responsibility in respect to certain inspections, tests and approvals is set forth in paragraph 13.02.

8.08 Limitation on OWNER's Responsibility

- A. The OWNER shall not supervise, direct or have control or authority over, nor be responsible for, CONTRACTOR's means, methods, techniques, sequences or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of CONTRACTOR to comply with Laws and Regulations applicable to the furnishing or performance of the Work. OWNER will not be responsible for CONTRACTOR's failure to perform or furnish the Work in accordance with the Contract Documents.

8.09 Undisclosed Hazardous Materials

- A. OWNER's responsibility in respect of undisclosed Constituents of Concern uncovered or revealed at the Site is set forth in paragraph 4.06.

8.10 OWNER'S Designated Representative

- A. OWNER shall designate a person to act as its representatives during the performance of the Work. OWNER's designated representative will attend meetings and perform on behalf of OWNER all obligations required of OWNER under the provisions of the Contract Documents.

Article 9 ENGINEER's Status During Construction

9.01 OWNER's Representative

- A. ENGINEER will be OWNER's representative during the construction period. The duties and responsibilities and the limitations of authority of ENGINEER as OWNER'S representative during construction shall be as set forth in the Contract Documents.

9.02 Visits to Site

- A. ENGINEER may make visits to the Site at intervals appropriate to the various stages of construction to observe the progress and quality of the executed Work, and to determine solely for the benefit of OWNER, in general, if the Work is proceeding in accordance with the technical requirements of the Contract Documents. It will not be the responsibility of ENGINEER to make exhaustive or continuous on Site inspections to check the quality or quantity of the Work.

9.03 Resident Project Representative

- A. If OWNER and ENGINEER agree, ENGINEER will furnish a Resident Project Representative to assist ENGINEER in providing more continuous observation of the Work. A Resident Project Representative will act as directed by and under the supervision of ENGINEER and will confer with ENGINEER regarding his actions. Resident Project Representative's dealings in matters pertaining to the on Site Work shall in general be only with ENGINEER and CONTRACTOR, and dealings with Subcontractors shall only be through or with the full knowledge of CONTRACTOR. The Resident Project Representative's duties and responsibilities include:
1. Schedules
 - a. Review the Progress Schedule, Schedule of Submittals and Schedule of Values prepared by CONTRACTOR.
 2. Conferences
 - a. Arrange a schedule of progress meetings and other job conferences as required in consultation with ENGINEER and OWNER, and notify those expected to attend in advance.
 3. Liaison
 - a. Serve as ENGINEER's liaison with CONTRACTOR, working principally through CONTRACTOR's superintendent and assist him in understanding the intent of the technical aspects of the Contract Documents. Assist ENGINEER in serving as OWNER's liaison with CONTRACTOR when CONTRACTOR's operations affect OWNER's on Site operations.
 4. Shop Drawings and Samples
 - a. Advise ENGINEER and CONTRACTOR, or CONTRACTOR's superintendent, immediately of the commencement of any Work requiring a Shop Drawing or Sample submission if the submission was identified on the schedule and has not been reviewed by ENGINEER.
 5. Review of Work, Rejection of Defective Work, Inspections, and Tests:
 - a. Conduct on Site observations of the Work and report to ENGINEER whenever Resident Project Representative believes that technical aspects of any executed Work is unsatisfactory, faulty or defective or does not meet the requirements of any inspections, tests or approval required to be made or has been damaged prior to final payment; and advise ENGINEER when Resident Project Representative believes that any partially completed portion of the Work should be corrected or rejected or should be uncovered for observation, or requires special testing, inspection or approval.
 - b. Observe, record and report to ENGINEER appropriate details relative to test procedures and startups.
 - c. Accompany visiting inspectors representing public or other agencies having jurisdiction over the Project, record the outcome of these inspections and report to ENGINEER.

6. Modifications
 - a. Consider CONTRACTOR's suggestions for modifications in Plans or Specifications and report them to ENGINEER.
7. Reports
 - a. Prepare periodic reports as required of progress of the Work and CONTRACTOR's compliance with the approved Progress Schedule and Schedule of Submittals.
8. Completion
 - a. Verify that all items on final list of items requiring completion or correction have been completed or corrected and make recommendations to ENGINEER concerning acceptance.
9. Exceptions
 - a. Resident Project Representative:
 - (1) Shall not authorize any deviation from the Contract Documents or approve any substitute materials or equipment.
 - (2) Shall not approve or accept any portion of the completed Work.
 - (3) Shall not undertake any of the responsibilities of CONTRACTOR, Subcontractors or CONTRACTOR's superintendent, or expedite the Work.
 - (4) Shall not advise on or issue directions relative to any aspect of the means, methods, techniques, sequences or procedures of construction unless such is specifically called for in the Contract Documents.
 - (5) Shall not advise on or issue directions as to safety precautions and programs in connection with the Work.
 - (6) Shall not advise on or issue directions regarding CONTRACTOR's failure to comply with Laws and Regulations applicable to the furnishing or performance of the Work.

9.04 Clarifications and Interpretations

- A. ENGINEER will issue with reasonable promptness such written clarifications or interpretations of the Contract Documents as ENGINEER may determine necessary, which shall be consistent with or reasonably inferable from the overall intent of the Contract Documents.

9.05 Authorized Variations in Work - Field Order

- A. ENGINEER may authorize minor adjustments in the Work to avoid obstructions or interferences which do not involve an adjustment in the Contract Price or the Contract Time, and which are consistent with the overall intent of the Contract Documents. These may be accomplished by a Field Order and shall be binding on OWNER, and also on CONTRACTOR who shall perform the change promptly. If OWNER or CONTRACTOR believes that a Field Order justifies an adjustment in

the Contract Price or Contract Times, or both, and the parties are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a request for a Change Proposal may be made therefore as provided in paragraph 10.06 or a Claim may be submitted as set forth in paragraph 11.01.

9.06 Rejecting Defective Work

- A. ENGINEER will have authority to disapprove or reject completed portions of the Work which ENGINEER believes to be defective and will also have authority to require special inspection or testing of the Work as provided in paragraph 13.04, whether or not the Work is fabricated, installed or completed.

9.07 Shop Drawings, Change Orders, and Payments

- A. ENGINEER's responsibility for Shop Drawings and samples are set forth in paragraphs 6.19 through 6.21 inclusive.
- B. ENGINEER's responsibilities as to Change Orders are set forth in Articles 10, 11, and 12.
- C. ENGINEER's responsibilities in respect of Applications for Payment are set forth in Article 14.

9.08 Determinations for Unit Price Work

- A. ENGINEER will determine the actual quantities and classifications of Unit Price Work performed by CONTRACTOR. ENGINEER will review with CONTRACTOR ENGINEER's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). ENGINEER's written decision thereon will be final and binding (except as modified by ENGINEER to reflect changed factual conditions or more accurate data) upon OWNER and CONTRACTOR, subject to the provisions of paragraph 10.06.

9.09 Decisions on Disagreements, Claims

- A. ENGINEER will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work performed thereunder. Claims, disputes and other matters relating to the acceptability of the Work, or the interpretation of the requirements of the Contract Documents pertaining to the execution and progress of the Work, shall be referred initially to ENGINEER in writing with a request for a formal decision in accordance with this paragraph 9.09.
- B. ENGINEER will, with reasonable promptness, render a written decision on the issue referred. If OWNER or CONTRACTOR believe that any such decision entitles them to an adjustment in the Contract Price, or Contract Times, or both, a Claim may be made under paragraph 11.01.
- C. ENGINEER's written decision on the issue referred will be final and binding on OWNER and CONTRACTOR, subject to the provisions of paragraph 11.01.
- D. In this capacity ENGINEER will not show partiality to OWNER or CONTRACTOR and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity.

9.10 Limitations on ENGINEER's Responsibilities

- A. Neither ENGINEER's authority to act under this Article 9 or elsewhere in the Contract Documents, nor any decision made by ENGINEER in good faith either to exercise or not exercise such authority, shall give rise to any duty or responsibility of ENGINEER to OWNER or CONTRACTOR, any Subcontractor, any manufacturer, fabricator, Supplier, distributor, surety, or any other person, employee, or agent of any of them.
- B. ENGINEER will not supervise, direct, control or have authority over, or be responsible for CONTRACTOR's means, methods, techniques, sequences or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of CONTRACTOR to comply with Laws and Regulations applicable to the furnishing or performance of the Work. ENGINEER will not be responsible for CONTRACTOR's failure to perform the Work in accordance with the Contract Documents. These limitations on authority and responsibility shall also apply to ENGINEER's Consultant's, Resident Project Representative and assistants.
- C. ENGINEER will not be responsible for the acts or omissions of CONTRACTOR or of any Subcontractor, Supplier, or of any other individual or entity performing any of the Work.
- D. ENGINEER will not be responsible to CONTRACTOR or any Subcontractor, or Supplier, or to their agents or employees for injuries, damages, claims, losses, or expenses (including attorney's fees) of whatsoever kind resulting from or caused by any act or omission of ENGINEER in preparation for, arising from, relating to, or concerning the Project. Such acts or omissions include, but are not limited to, ENGINEER's negligence, tortuous conduct, errors, omissions, strict liability, breach of contract, or breach of warranty. ENGINEER makes no representations to CONTRACTOR, Subcontractors, Suppliers or their agents or employees regarding or respecting any work performed by ENGINEER in preparation for, arising from, relating to, or concerning the Project.
- E. Neither CONTRACTOR, its agents or employees, nor any Subcontractors or Suppliers or their agents or employees, are intended beneficiaries of ENGINEER's agreement with OWNER, nor are such parties intended beneficiaries of ENGINEER's duties or responsibilities arising therefrom. ENGINEER disclaims all duties to CONTRACTOR, Subcontractors, Suppliers or their agents or employees arising from, relating to, or concerning ENGINEER's involvement in the Project. OWNER and CONTRACTOR further agree to notify all CONTRACTOR's, Subcontractors or Suppliers of this disclaimer of ENGINEER's liability and require them to abide by this disclaimer.

Article 10 Amending the Contract Documents; Changes in the Work

10.01 Amending and Supplementing Contract Documents

- A. The Contract Documents may be amended or supplemented by a Change Order, a Work Change Directive, or a Field Order.
 - 1. Change Orders:
 - a. If an amendment or supplement to the Contract Documents includes a change in the Contract Price or the Contract Times, such amendment or supplement must be set forth in a Change Order. A Change Order also may be used to establish amendments and supplements of the Contract Documents that do not affect the Contract Price or Contract Times.

- b. OWNER and CONTRACTOR may amend those terms and conditions of the Contract Documents that do not involve;
 - (1) the performance or acceptability of the Work,
 - (2) the design (as set forth in the Drawings, Specifications, or otherwise), or
 - (3) other engineering or technical matters, without the recommendation of ENGINEER. Such an amendment shall be set forth in a Change Order.
- 2. Work Change Directives.
 - a. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the modification ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order, following negotiations by the parties as to the Work Change Directive's effect, if any, on the Contract Price and Contract Times; or, if negotiations are unsuccessful, by a determination under the terms of the Contract Documents governing adjustments, expressly including paragraph 10.04 regarding change of Contract Price.
 - b. CONTRACTOR must submit any Change Proposal seeking an adjustment of the Contract Price or the Contract Times, or both, no later than 30 days after the issuance of the Work Change Directive.
 - c. OWNER must submit any Claim seeking an adjustment of the Contract Price or the Contract Times, or both, no later than 60 days after issuance of the Work Change Directive.
- 3. Field Orders.
 - a. ENGINEER may authorize minor changes in the Work if the changes do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Such changes will be accomplished by a Field Order and will be binding on OWNER and CONTRACTOR, which shall perform the Work involved promptly.
 - b. If CONTRACTOR believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, then before proceeding with the Work at issue, CONTRACTOR shall submit a Change Proposal as provided herein.

10.02 OWNER-Authorized Changes in the Work

- A. Without invalidating the Contract and without notice to any surety, OWNER may, at any time or from time to time, order additions, deletions, or revisions in the Work. Such changes shall be supported by ENGINEER's recommendation, to the extent the change involves the design (as set forth in the Drawings, Specifications, or otherwise), or other engineering or technical matters. Such changes may be accomplished by a Change Order, if OWNER and CONTRACTOR have agreed as to the effect, if any, of the changes on Contract Times or Contract Price; or by a Work Change Directive.

- B. Upon receipt of any such document, CONTRACTOR shall promptly proceed with the Work involved; or, in the case of a deletion in the Work, promptly cease construction activities with respect to such deleted Work. Added or revised Work shall be performed under the applicable conditions of the Contract Documents. Nothing in this paragraph 10.02 shall obligate CONTRACTOR to undertake work that CONTRACTOR reasonably concludes cannot be performed in a manner consistent with CONTRACTOR's safety obligations under the Contract Documents or Laws and Regulations.

10.03 Unauthorized Changes in the Work

- A. CONTRACTOR shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents, as amended, modified, or supplemented, except in the case of an emergency as provided in paragraph 6.18 or in the case of uncovering Work as provided in paragraph 13.03.

10.04 Change of Contract Price

- A. The Contract Price may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Price shall comply with the provisions of paragraph 10.06. Any Claim for an adjustment of Contract Price shall comply with the provisions of paragraph 11.01.
- B. An adjustment in the Contract Price will be determined as follows:
 - 1. where the Work involved is covered by Unit Prices contained in the Contract Documents, then by application of such Unit Prices to the quantities of the items involved (subject to the provisions of paragraph 12.03); or
 - 2. where the Work involved is not covered by Unit Prices contained in the Contract Documents, then by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with paragraph 10.04.C.2); or
 - 3. where the Work involved is not covered by Unit Prices contained in the Contract Documents and the parties do not reach mutual agreement to a lump sum, then on the basis of the Cost of the Work (determined as provided in paragraph 12.01) plus a CONTRACTOR's fee for overhead and profit (determined as provided in paragraph 10.04.C).
- C. CONTRACTOR's Fee: When applicable, the CONTRACTOR's fee for overhead and profit shall be determined as follows:
 - 1. a mutually acceptable fixed fee; or
 - 2. if a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:
 - a. for costs incurred under paragraph 12.01.B.1 and 12.01.B.2, the CONTRACTOR's fee shall be 15 percent;
 - b. for costs incurred under paragraph 12.01.B.3, the CONTRACTOR's fee shall be five percent;
 - c. where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of paragraphs 10.04.C.2.a and 10.04.C.2.b is that the CONTRACTOR's fee shall be based on:

- (1) a fee of 15 percent of the costs incurred under paragraphs 12.01.B.1 and 12.01.B.2 by the Subcontractor that actually performs the Work, at whatever tier, and
- (2) with respect to CONTRACTOR itself and to any Subcontractors of a tier higher than that of the Subcontractor that actually performs the Work, a fee of 5 percent of the amount (fee plus underlying costs incurred) attributable to the next lower tier Subcontractor;

provided, however, that for any such subcontracted work the maximum total fee to be paid by OWNER shall be no greater than 27 percent of the costs incurred by the Subcontractor that actually performs the Work;

- d. no fee shall be payable on the basis of costs itemized under paragraphs 12.01.B.4, 12.01.B.5, and 12.01.C;
- e. the amount of credit to be allowed by CONTRACTOR to OWNER for any change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in CONTRACTOR's fee by an amount equal to 5 percent of such net decrease; and
- f. when both additions and credits are involved in any one change, the adjustment in CONTRACTOR's fee shall be computed on the basis of the net change in accordance with paragraphs 10.04.C.2.a through 10.04.C.2.e, inclusive.

10.05 Change of Contract Times

- A. The Contract Times may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Times shall comply with the provisions of paragraph 10.06. Any Claim for an adjustment in the Contract Times shall comply with the provisions of paragraph 11.01.
- B. An adjustment of the Contract Times shall be subject to the limitations set forth in paragraph 12.04, concerning delays in CONTRACTOR's progress.

10.06 Change Proposals

- A. CONTRACTOR shall submit a Change Proposal to ENGINEER to request an adjustment in the Contract Times or Contract Price; appeal an initial decision by ENGINEER concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; contest a set-off against payment due; or seeking other relief under the Contract. The Change Proposal shall specify any proposed change in Contract Times or Contract Price, or both, or other proposed relief, and explain the reason for the proposed change, with citations to any governing or applicable provisions of the Contract Documents. Each Change Proposal will address only 1 issue, or a set of closely related issues.
 1. Procedures. CONTRACTOR shall submit each Change Proposal to ENGINEER promptly (but in no event later than 5 days) after the start of the event giving rise thereto, or after such initial decision. CONTRACTOR shall submit supporting data, including the proposed change in Contract Price or Contract Time (if any) to ENGINEER and OWNER within 15 days

after the submittal of the Change Proposal. The supporting data shall be accompanied by a written statement that the supporting data are accurate and complete, and that any requested time or price adjustment is the entire adjustment to which CONTRACTOR believes it is entitled as a result of said event. ENGINEER will advise OWNER regarding the Change Proposal and consider any comments or response from OWNER regarding the Change Proposal.

2. ENGINEER's Action. ENGINEER will review each Change Proposal and, within 30 days after receipt of the CONTRACTOR's supporting data, either deny the Change Proposal in whole, approve it in whole, or deny it in part and approve it in part. Such actions shall be in writing, with a copy provided to OWNER and CONTRACTOR. If ENGINEER does not take action on the Change Proposal within 30 days, then either OWNER or CONTRACTOR may at any time thereafter submit a letter to the other party indicating that as a result of the ENGINEER's inaction the Change Proposal is deemed denied, thereby commencing the time for appeal of the denial under paragraph 11.01.
 3. Binding Decision. ENGINEER's decision will be final and binding upon OWNER and CONTRACTOR, unless OWNER or CONTRACTOR appeals the decision by filing a Claim under paragraph 11.01.
- B. Resolution of Certain Change Proposals: If the Change Proposal does not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters, then ENGINEER will notify the parties that the ENGINEER is unable to resolve the Change Proposal. For purposes of further resolution of such a Change Proposal, such notice shall be deemed a denial, and CONTRACTOR may choose to seek resolution under the terms of paragraph 11.01.

10.07 Execution of Change Orders

- A. OWNER and CONTRACTOR shall execute appropriate Change Orders covering:
1. changes in the Contract Price or Contract Times which are agreed to by the Parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive;
 2. changes in Contract Price resulting from an OWNER set-off, unless CONTRACTOR has duly contested such set-off;
 3. changes in the Work which are:
 - a. ordered by OWNER pursuant to paragraph 10.02,
 - b. required because of OWNER's acceptance of defective Work under paragraph 13.08 or OWNER's correction of defective Work under paragraph 13.09, or
 - c. agreed to by the parties, subject to the need for ENGINEER's recommendation if the change in the Work involves the design (as set forth in the Drawings, Specifications, or otherwise), or other engineering or technical matters; and
 4. changes in the Contract Price or Contract Times, or other changes, which embody the substance of any final and binding results under paragraph 10.06, or Article 16.

- B. If OWNER or CONTRACTOR refuses to execute a Change Order that is required to be executed under the terms of this paragraph 10.07, it shall be deemed to be of full force and effect, as if fully executed.

10.08 Notification to Surety

- A. If the provisions of any bond require notice to be given to a surety of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times), the giving of any such notice will be CONTRACTOR's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

Article 11 Claims

11.01 Claims

- A. Claims Process: The following disputes between OWNER and CONTRACTOR shall be submitted to the Claims process set forth in this Article:
 - 1. Appeals by OWNER or CONTRACTOR of ENGINEER's decisions regarding Change Proposals;
 - 2. OWNER demands for adjustments in the Contract Price or Contract Times, or other relief under the Contract Documents; and
 - 3. Disputes that ENGINEER has been unable to address because they do not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters.
- B. Submittal of Claim: The party submitting a Claim shall deliver it directly to the other party to the Contract promptly (but in no event later than 10 days) after the start of the event giving rise thereto; in the case of appeals regarding Change Proposals within 30 days of the decision under appeal. The party submitting the Claim shall also furnish a copy to the ENGINEER, for its information only. The responsibility to substantiate a Claim shall rest with the party making the Claim. In the case of a Claim by CONTRACTOR seeking an increase in the Contract Times or Contract Price, or both, CONTRACTOR shall certify that the Claim is made in good faith, that the supporting data are accurate and complete, and that to the best of CONTRACTOR's knowledge and belief the amount of time or money requested accurately reflects the full amount to which CONTRACTOR is entitled.
- C. Review and Resolution: The party receiving a Claim shall review it thoroughly, giving full consideration to its merits. The two parties shall seek to resolve the Claim through the exchange of information and direct negotiations. The parties may extend the time for resolving the Claim by mutual agreement. All actions taken on a Claim shall be stated in writing and submitted to the other party, with a copy to ENGINEER.
- D. Mediation:
 - 1. At any time after initiation of a Claim, OWNER and CONTRACTOR may mutually agree to mediation of the underlying dispute. The agreement to mediate shall stay the Claim submittal and response process.
 - 2. If OWNER and CONTRACTOR agree to mediation, then after 60 days from such agreement, either OWNER or CONTRACTOR may unilaterally terminate the mediation process, and the Claim submittal and decision process shall resume as of the date of the termination.

If the mediation proceeds but is unsuccessful in resolving the dispute, the Claim submittal and decision process shall resume as of the date of the conclusion of the mediation, as determined by the mediator.

3. OWNER and CONTRACTOR shall each pay one-half of the mediator's fees and costs.
- E. Partial Approval: If the party receiving a Claim approves the Claim in part and denies it in part, such action shall be final and binding unless within 30 days of such action the other party invokes the procedure set forth in Article 16 for final resolution of disputes.
- F. Denial of Claim: If efforts to resolve a Claim are not successful, the party receiving the Claim may deny it by giving written notice of denial to the other party. If the receiving party does not take action on the Claim within 90 days, then either OWNER or CONTRACTOR may at any time thereafter submit a letter to the other party indicating that as a result of the inaction, the Claim is deemed denied, thereby commencing the time for appeal of the denial. A denial of the Claim shall be final and binding unless within 30 days of the denial the other party invokes the procedure set forth in Article 16 for final resolution of disputes.
- G. Final and Binding Results: If the parties reach a mutual agreement regarding a Claim, whether through approval of the Claim, direct negotiations, mediation, or otherwise; or if a Claim is approved in part and denied in part, or denied in full, and such actions become final and binding; then the results of the agreement or action on the Claim shall be incorporated in a Change Order to the extent they affect the Contract, including the Work, the Contract Times, or the Contract Price.

Article 12 Cost of the Work; Allowances; Unit Price Work

12.01 Cost of Work

- A. Purposes for Determination of Cost of the Work: The term Cost of the Work means the sum of all costs necessary for the proper performance of the Work at issue, as further defined below. The provisions of this paragraph 12.01 are used to determine the value of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price. When the value of any such adjustment is determined on the basis of Cost of the Work, CONTRACTOR is entitled only to those additional or incremental costs required because of the change in the Work or because of the event giving rise to the adjustment.
- B. Costs Included: Except as otherwise may be agreed to in writing by OWNER, costs included in the Cost of the Work shall be in amounts no higher than those prevailing in the locality of the Project, shall not include any of the costs itemized in paragraph 12.01.C, and shall include only the following items:
 1. Payroll costs for employees in the direct employ of CONTRACTOR in the performance of the Work under schedules of job classifications agreed upon by OWNER and CONTRACTOR. Such employees shall include, without limitation, superintendents, foremen, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, bonuses, sick leave, and vacation and holiday pay applicable thereto. The expenses of

performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, shall be included in the above to the extent authorized by OWNER.

2. Costs of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts shall accrue to CONTRACTOR unless OWNER deposits funds with CONTRACTOR with which to make payments, in which case the cash discounts shall accrue to OWNER. All trade discounts, rebates, and refunds and returns from sale of surplus materials and equipment shall accrue to OWNER, and CONTRACTOR shall make provisions so that they may be obtained.
3. Payments made by CONTRACTOR to Subcontractors for Work performed by Subcontractors. If required by OWNER, CONTRACTOR shall obtain competitive bids from Subcontractors acceptable to OWNER and CONTRACTOR and shall deliver such bids to OWNER, who will then determine, with the advice of ENGINEER, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee shall be determined in the same manner as CONTRACTOR's Cost of the Work and fee as provided in this paragraph 12.01.
4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed for services specifically related to the Work.
5. Supplemental costs including the following:
 - a. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of CONTRACTOR.
 - b. Rentals of all construction equipment and machinery, and the parts thereof, whether rented from CONTRACTOR or others in accordance with rental agreements approved by OWNER with the advice of ENGINEER, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.
 - (1) The rental rate established for each piece of CONTRACTOR owned equipment, including appurtenances and attachments to the equipment, used will be determined by use of the Rental Rate Blue Book for Construction Equipment, Volume 1, 2 or 3, as applicable; the edition which is current at the time the Work was started will apply. The established rental rate will be equal to the "Monthly" rate divided by 176;

modified by the rate adjustment factor and the applicable map adjustment factor, plus the "Estimated Operating Costs per Hour."

- (2) For equipment not listed in the Rental Rate Blue Book, Volume 1, 2 or 3, the rental rate will be determined by using the rate listed for a similar piece of equipment or by proportioning a rate listed so that the capacity, size, horsepower, and age are properly considered.
 - (3) For equipment for which there are no comparables in the Rental Rate Blue Book, Volume 1, 2 or 3, the monthly rate shall be reasonable, but not more than 5 percent of the current list price, or invoice, of the equipment. The base hourly rate shall then be determined by dividing the monthly rate by 176 to which 20 percent will be added to the sum which will account for adjustments and operating costs.
 - c. Sales, consumer, use, and other similar taxes related to the Work, and for which CONTRACTOR is liable, as imposed by laws and regulations.
 - d. Deposits lost for causes other than negligence of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.
 - e. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by CONTRACTOR in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with paragraph 5.03), provided such losses and damages have resulted from causes other than the negligence of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of OWNER. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining
 - f. The cost of utilities, fuel, and sanitary facilities at the Site.
 - g. The costs of premiums for all bonds and insurance that CONTRACTOR is required by the Contract Documents to purchase and maintain.
- C. Costs Excluded: The term Cost of the Work shall not include any of the following items:
- 1. Payroll costs and other compensation of CONTRACTOR's officers, executives, principals (of partnerships and sole proprietorships), general managers, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks, and other personnel employed by CONTRACTOR,

whether at the Site or in CONTRACTOR's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in paragraph 12.01.B.1 or specifically covered by paragraph 12.01.B.4. The payroll costs and other compensation excluded here are to be considered administrative costs covered by the CONTRACTOR's fee.

2. Expenses of CONTRACTOR's principal and branch offices other than CONTRACTOR's office at the Site.
 3. Any part of CONTRACTOR's capital expenses, including interest on CONTRACTOR's capital employed for the Work and charges against CONTRACTOR for delinquent payments.
 4. Costs due to the negligence of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.
 5. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in paragraph 12.01.B.
- D. CONTRACTOR's Fee: When the value of any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price is determined on the basis of Cost of the Work, CONTRACTOR's fee shall be determined as set forth in paragraph 10.04.C.
- E. Documentation: Whenever the Cost of the Work for any purpose is to be determined pursuant to this Article 12, CONTRACTOR will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in a form acceptable to ENGINEER on a daily basis, an itemized cost breakdown together with supporting data.

12.02 Allowances

- A. It is understood that CONTRACTOR has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to OWNER and ENGINEER.
- B. Cash Allowances: CONTRACTOR agrees that:
1. the cash allowances include the cost to CONTRACTOR (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and
 2. CONTRACTOR's costs for unloading and handling of the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment on account of any of the foregoing will be valid.
- C. Contingency Allowance: CONTRACTOR agrees that a contingency allowance, if any, is for the sole use of OWNER to cover unanticipated costs.

- D. Prior to final payment, an appropriate Change Order will be issued as recommended by ENGINEER to reflect actual amounts due CONTRACTOR on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

12.03 Unit Price Work

- A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Proposal.
- B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Payments to CONTRACTOR for Unit Price Work will be based on actual quantities.
- C. Each Unit Price will be deemed to include an amount considered by CONTRACTOR to be adequate to cover CONTRACTOR's overhead and profit for each separately identified item.
- D. ENGINEER will determine the actual quantities and classifications of Unit Price Work performed by CONTRACTOR. ENGINEER will review with CONTRACTOR the ENGINEER's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). ENGINEER's written decision thereon will be final and binding (except as modified by ENGINEER to reflect changed factual conditions or more accurate data) upon OWNER and CONTRACTOR, subject to the provisions of the following paragraph 12.03.E.
- E. Within 30 days of ENGINEER's written decision under the preceding paragraph 12.03.D, CONTRACTOR may submit a Change Proposal, or OWNER may file a Claim, seeking and adjustment in the Contract Price if:
 - 1. the quantity of any item of Unit Price Work performed by CONTRACTOR differs materially and significantly from the estimate quantity of such item indicated in the Proposal (in no event will any change in quantities of less than 25% be considered a material or significant change from the estimated quantities); and
 - 2. there is no corresponding adjustment with respect to any other item of Work.

12.04 Delays in CONTRACTOR's Progress

- A. If OWNER, ENGINEER, or anyone for whom OWNER is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then CONTRACTOR shall be entitled to request an equitable adjustment in the Contract Times and Contract Price. However, CONTRACTOR's entitlement to an adjustment of the Contract Times or Contract Price is expressly conditioned on such adjustment being essential to CONTRACTOR's ability to complete the Work within the Contract Times.
- B. CONTRACTOR shall not be entitled to an adjustment in Contract Price or Contract Times for delay, disruption, or interference caused by or within the control of CONTRACTOR. Delay, disruption, and interference attributable to and within the control of a SUBCONTRACTOR or Supplier shall be deemed to be within the control of CONTRACTOR.

- C. If CONTRACTOR's performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault and beyond the control of OWNER, CONTRACTOR, and those for which they are responsible, then CONTRACTOR shall be entitled to an equitable adjustment in Contract Times. CONTRACTOR's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to CONTRACTOR's ability to complete the Work within the Contract Times. Such an adjustment shall be CONTRACTOR's sole and exclusive remedy for the delays, disruption, and interference described in this paragraph. Causes of delay, disruption, or interference that may give rise to an adjustment in Contract Times under this paragraph include only the following:
1. severe and unavoidable natural catastrophes such as fires, floods, epidemics, and earthquakes;
 2. acts or failures to act of utility owners (other than those performing other works at or adjacent to the Site by arrangement with the OWNER, as specified in paragraph 7.01); and
 3. acts of war or terrorism.
- D. CONTRACTOR's entitlement to an adjustment of Contract Times or Contract Price is limited as follows:
1. CONTRACTOR's entitlement to an adjustment of the Contract Times is conditioned on the delay, disruption, or interference adversely affecting an activity on the critical path to completion of the Work, as of the time of the delay, disruption, or interference.
 2. CONTRACTOR shall not be entitled to an adjustment in Contract Price for any delay, disruption, or interference if such delay is concurrent with a delay, disruption, or interference caused by or within the control of CONTRACTOR. Such a concurrent delay by CONTRACTOR shall not preclude an adjustment of Contract Times to which CONTRACTOR is otherwise entitled.
 3. Adjustments of Contract Times or Contract Price are subject to the provisions of Article 10.
- E. Each CONTRACTOR request or Change Proposal seeking an increase in Contract Times or Contract Price must be supplemented by supporting data that sets forth in detail the following:
1. The circumstances that form the basis for the requested adjustment;
 2. The date upon which each cause of delay, disruption, or interference began to affect the progress of the Work;
 3. The date upon which each cause of delay, disruption, or interference ceased to affect the progress of the Work;
 4. The number of days' increase in Contract Times claimed as a consequence of each such cause of delay, disruption, or interference; and
 5. The impact on Contract Price, in accordance with the provisions of Paragraph 10.04.

CONTRACTOR shall also furnish such additional supporting documentation as OWNER or ENGINEER may require including, where appropriate, a revised Progress Schedule indicating all the activities affected by the delay, disruption, or interference, and an explanation of the effect of the delay, disruption, or interference on the critical path to completion of the Work

- F. Delays, disruption, and interference to the performance or progress of the Work resulting from the existence of a differing subsurface or physical condition, an Underground Facility that was not shown or indicated by the Contract Documents, or not shown or indicated with reasonable accuracy, and those resulting from Hazardous Environmental Conditions, are governed by paragraphs 4.03 and 4.06.
- G. Paragraph 7.01 governs delays, disruption, and interference to the performance or progress of the Work resulting from the performance of certain other work at or adjacent to the Site.
- H. CONTRACTOR shall not be entitled to any adjustment in Contract Price or Contract Times for any delay, disruption, or interference if such delay is concurrent with a delay, disruption, or interference caused by or within the control of CONTRACTOR.
- I. CONTRACTOR must submit any Change Proposal seeking an adjustment in Contract Price or Contract Times under this paragraph within 5 days of the commencement of the delaying, disrupting, or interfering event.
- J. Where CONTRACTOR is prevented from completing any part of the Work within the Contract Time (or Milestones) due to delay beyond the control of both OWNER and CONTRACTOR, an extension of the Contract Times (or Milestones) in an amount equal to the time lost due to such delay shall be CONTRACTOR's sole and exclusive remedy for such delay. In no event shall OWNER or ENGINEER be liable to CONTRACTOR, any Subcontractor, any Supplier, or any other person or organization, or to any surety or employee or any agent of them, for damages, including but not limited to all fees and charges of ENGINEERS, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs, arising out of or resulting from:
 - 1. delays caused by or within the control of CONTRACTOR (or Subcontractor or Supplier);
 - 2. delays beyond the control of both OWNER and CONTRACTOR, including but not limited to fires, floods, epidemics, abnormal weather conditions, acts of God, or acts of neglect by utility owners or other contractors performing other work;
- K. Nor shall OWNER or ENGINEER or each of them be liable to CONTRACTOR for any claims, costs, losses or damages sustained by CONTRACTOR on or in connection with any other project or anticipated project.
- L. Nothing in this paragraph 12.04 bars a change in Contract Price to compensate CONTRACTOR due to delay, interference, or disruption directly attributable to actions or inactions of OWNER or anyone for whom OWNER is responsible. Except for an adjustment to the Contract Times and Contract Price, the CONTRACTOR shall not be entitled to and hereby waives any and all damages that it may suffer by reason of such delay or for any Act of God, including but not limited lost profits, overhead, and other consequential damages.

Article 13 Tests and Inspection; Correction, Removal or Acceptance of Defective Work

13.01 Access to Work

- A. OWNER, ENGINEER and ENGINEER's representatives, other representatives of OWNER, testing agencies and governmental agencies with jurisdictional interests will have access to the Work at reasonable times for their observation, inspection and testing. CONTRACTOR shall provide proper and safe conditions for such access and advise OWNER and ENGINEER of CONTRACTOR's Site safety procedures and programs so that OWNER and ENGINEER may comply therewith as applicable.

13.02 Tests and Inspections

- A. CONTRACTOR shall give ENGINEER and testing agency at least 24-hour notice, unless otherwise specified, of readiness of the Work for all required inspections, tests or approvals, and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.
- B. If any Law and Regulation, code, or order of any public body having jurisdiction requires any Work or part thereof to specifically be inspected, tested or approved, CONTRACTOR shall assume full responsibility therefor, pay all costs in connection therewith and furnish ENGINEER the required certificates of inspection, testing or approval.
- C. CONTRACTOR shall also be responsible for and shall pay all costs in connection with any inspection or testing required in connection with OWNER's or ENGINEER's acceptance of a manufacturer, fabricator, Supplier or distributor of materials or equipment proposed to be incorporated in the Work, or of materials or equipment submitted for approval prior to CONTRACTOR's purchase thereof for incorporation in the Work.
- D. The cost of all other inspections, tests and approvals required by the Contract Documents shall be paid by OWNER unless otherwise specified.
- E. All inspections, tests or approvals other than those required by law, ordinance, rule, regulation, code or order of any public body having jurisdiction shall be performed by organizations acceptable to OWNER and CONTRACTOR or by ENGINEER if so specified.
- F. Cost of materials to be used in inspection and transportation costs shall be paid for by the CONTRACTOR.
- G. Neither observations by ENGINEER nor inspections, tests or approvals by others shall relieve CONTRACTOR from his obligations to perform the Work in accordance with the Contract Documents.

13.03 Uncovering Work

- A. If any Work that is to be tested, inspected or approved is covered without written concurrence of ENGINEER, or contrary to the written request of ENGINEER, it shall, if requested by ENGINEER, be uncovered by CONTRACTOR for ENGINEER's observation. Such uncovering shall be at CONTRACTOR's expense unless CONTRACTOR has given ENGINEER timely written notice of his intention to cover such Work and ENGINEER has not acted with reasonable promptness in response to such notice.

- B. If ENGINEER considers it necessary or advisable that covered Work be observed by ENGINEER or inspected or tested by others, CONTRACTOR, at ENGINEER's request, shall uncover, expose or otherwise make available for observation, inspection or testing as ENGINEER may require, that portion of the Work in question, furnishing all necessary labor, material, and equipment. Except as otherwise specified in paragraph 13.04, the cost of Work shall be paid for as follows:
1. If it is found that such Work is defective, CONTRACTOR shall bear all the expenses of such uncovering, exposure, observation, inspection and testing, and of satisfactory reconstruction, (including, but not limited to, fees and charges of engineers, architects, attorneys, and other professionals) and an appropriate deductive Change Order shall be issued. If the parties are unable to agree as to the amount or extent of any change in Contract Price or Contract Time, OWNER may make a Claim as provided in paragraph 11.01.
 2. If, however, such Work is not found to be defective, CONTRACTOR shall be allowed an increase in the Contract Price or an extension of the Contract Time or both, directly attributable to such uncovering, exposure, observation, inspection, testing, and reconstruction. If the parties are unable to agree as to the amount or extent of any change in Contract Price or Contract Time, CONTRACTOR may make a Claim as provided in paragraph 11.01.

13.04 Defective Work

- A. CONTRACTOR's Obligation: It is CONTRACTOR's obligation to assure that the Work is not defective.
- B. ENGINEER's Authority: ENGINEER has the authority to determine whether Work is defective, and to reject defective Work.

13.05 OWNER May Stop the Work

- A. If the Work is defective, or CONTRACTOR fails to supply sufficient skilled workers or suitable materials or equipment, or fails to furnish or perform the Work in such a way that the completed Work will conform to the Contract Documents, OWNER may order CONTRACTOR to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of OWNER to stop the Work shall not give rise to any duty on the part of OWNER to exercise this right for the benefit of CONTRACTOR, any Subcontractor, Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

13.06 Correction or Removal of Defective Work

- A. If required by ENGINEER or OWNER, CONTRACTOR shall promptly either correct all defective Work, whether or not fabricated, installed or completed, or if the Work has been rejected by ENGINEER, remove it from the Site and replace it with non-defective Work. CONTRACTOR shall pay all claims, costs, losses, damages and expenses caused by or resulting from such correction or removal (including, but not limited to all costs of repair or replacement of work of others) and shall take no action that would void or otherwise impair OWNER's special warranty or guarantee, if any, on such Work.

13.07 Guarantee Period

- A. If within 1 year after the date of Substantial Completion (or such longer period of time as may be prescribed by Laws or Regulations or by the terms of any applicable special guarantee required by the Contract Documents), or by any specific provision of the Contract Documents, any Work is found to be defective, CONTRACTOR shall promptly, without cost to OWNER and in accordance with OWNER's written instructions:
 - 1. repair defective land or areas;
 - 2. correct such defective Work;
 - 3. if the defective Work has been rejected by OWNER, remove it from the Site and replace it with Work that is not defective, and
 - 4. satisfactorily correct or repair or remove and replace any damage to other Work or the work of others or other land or areas resulting therefrom.
- B. If CONTRACTOR does not promptly comply with the terms of such instructions, or in an emergency where delay would cause serious risk of loss or damage, OWNER may have the defective Work corrected or the rejected Work removed and replaced, and all claims, costs, losses, damages and expenses caused by or resulting from such removal and replacement (including but not limited to all costs of repair or replacement or work of others) shall be paid by CONTRACTOR.
- C. Repair or replacements made under the guarantee shall bear an additional 1 year guarantee dated from the acceptance of repair or replacement.

13.08 Acceptance of Defective Work

- A. If, instead of requiring correction or removal and replacement of defective Work, OWNER (and, prior to ENGINEER'S recommendation of final payment, also ENGINEER) prefers to accept it, OWNER may do so. CONTRACTOR shall pay all claims, costs, losses, damages and expenses attributable to OWNER's evaluation of and determination to accept such defective Work (such costs to be approved by ENGINEER as to reasonableness). In such case, if acceptance occurs prior to ENGINEER's recommendation of final payment, a Change Order shall be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and OWNER shall be entitled to an appropriate reduction in the Contract Price. If the acceptance occurs after such recommendation, an appropriate amount shall be paid by CONTRACTOR to OWNER.

13.09 OWNER May Correct Defective Work

- A. If CONTRACTOR fails within a reasonable time after written notice from ENGINEER to correct defective Work, or to remove and replace rejected Work as required by ENGINEER in accordance with paragraph 13.06, or if CONTRACTOR fails to perform the Work in accordance with the Contract Documents (including any requirements of the Progress Schedule), OWNER may, after 48 hours' written notice to CONTRACTOR and his Surety without prejudice to any other remedy he may have, correct and remedy any such deficiency.

- B. In exercising his rights and remedies under this paragraph 13.09, OWNER shall proceed expeditiously. To the extent necessary to complete corrective and remedial action, OWNER may exclude CONTRACTOR from all or part of the Site, take possession of all or part of the Work, and suspend CONTRACTOR's services related thereto, take possession of CONTRACTOR's tools, appliances, construction equipment and machinery at the Site and incorporate in the Work all materials and equipment stored at the Site or for which OWNER has paid CONTRACTOR but which are stored elsewhere. CONTRACTOR shall allow OWNER, OWNER's representatives, agents and employees, OWNER's other contractors, and ENGINEER's consultants such access to the Site as may be necessary to enable OWNER to exercise his rights and remedies under this paragraph 13.09.
- C. All claims, costs, losses, damages and expenses incurred or sustained by OWNER in exercising such rights and remedies shall be charged against CONTRACTOR and a Change Order shall be issued incorporating the necessary revisions in the Contract Documents with respect to the Work. OWNER shall be entitled to an appropriate reduction in the Contract Price equivalent to such claims, costs, losses, damages and expenses including but not be limited to all costs of repair or replacement of work of others destroyed or damaged by correction, removal or replacement of CONTRACTOR's defective Work.
- D. CONTRACTOR shall not be allowed an extension of the Contract Time because of any delay in performance of the Work attributable to the exercise by OWNER of OWNER's rights under this Article 13.

Article 14 Payments to CONTRACTOR and Completion

14.01 Schedules

- A. At least 10 days prior to submitting the first Application for Payment, CONTRACTOR shall submit to ENGINEER a final Schedule of Submittals, and, where applicable, a Schedule of Values for the Work. These schedules shall be satisfactory in form and substance to ENGINEER as provided in Article 2.
- B. The Schedule of Values shall include quantities and unit prices aggregating the Contract Price and shall subdivide the Work into component parts. Each unit cost so established shall include its proportionate share of 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. The total cost of the items and quantities CONTRACTOR lists in the Schedule of Values shall equal the total Contract Price established in the Proposal.
- C. 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.
- D. 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.
- E. Progress payments based upon Unit Price Work will be based upon the number of units completed.

14.02 Application for Progress Payment

- A. At least 20 days before each Application for Payment falls due (but not more often than once a month), CONTRACTOR shall submit to ENGINEER for review an Application for Payment, Contractor's Declaration, Payment Schedule, and updated Progress Schedules indicating the anticipated completion dates of the various stages of the Work and estimated payments during the next 3 months. Contractor's Application for Payment shall be filled out on the form provided in the Contract Documents and signed by CONTRACTOR covering the Work completed as of the date of the Application for Payment and accompanied by such supporting documentation as is required by the Contract Documents and as ENGINEER or OWNER may reasonably require. The Payment Schedule shall be on the form provided in the Contract Documents or in a format acceptable to the ENGINEER or OWNER. On the second and all subsequent payments, partial Waivers of Lien and Sworn Statement shall be required for all Work completed and paid for on previous certificates.
- B. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by such data, satisfactory to OWNER, as will establish OWNER's title to the material and equipment and protect OWNER's interest therein, including applicable insurance. A receipted vendor's invoice showing the quantities of materials and the amounts paid will be required and shall accompany the Application for Payment.
- C. Retainage with respect to progress payments will be in accordance with paragraph 14.03, and it will be retained until after completion of the entire Work and its final acceptance. When the amount to be retained is reduced to less than 10 percent, CONTRACTOR shall file with OWNER the written consent of the Surety to such reduction and shall furnish an affidavit that all CONTRACTOR's indebtedness by reason of the Contract has been paid.

14.03 Retainage

- A. On Contracts with a dollar value of \$30,000 and greater or on Contracts that provide for more than 3 progress payments, progress payments and retainage shall be governed by the provisions of any statutes, rules or regulations regarding retention and these are incorporated herein by reference and made a part of this Contract.
- B. If there are no statutes, rules, or regulations applicable to retention, retainage shall be 10%, or such an amount as OWNER deems necessary.

14.04 Review of Applications for Progress Payment

- A. ENGINEER will, within 10 days after receipt of each Contractor's Application for Payment and Payment Schedule, including each resubmittal, either indicate in writing a recommendation of payment and present an Engineer's Certificate for Payment to OWNER, or may return the Application to CONTRACTOR indicating in writing ENGINEER's reasons for refusing to recommend payment. In the latter case, CONTRACTOR may make the necessary corrections and resubmit the Application.

- B. ENGINEER's recommendation of any payment requested in CONTRACTOR's Application for Payment will constitute a representation by ENGINEER to OWNER, based on ENGINEER's review of the Contractor's Application for Payment and Certificate for Payment and the accompanying data and schedules, as an experienced and qualified design professional that to the best of ENGINEER's knowledge, information and belief;
1. the Work has progressed to the point indicated;
 2. the quality of the Work is in accordance with the technical aspects of the Contract Documents subject to an evaluation of the Work as a functioning Project upon Substantial Completion, to the results of any subsequent tests called for in the Contract Documents, a final determination of quantities and classifications for any Unit Price Work under paragraph 12.03, and any qualifications stated in the recommendation; and
 3. the conditions precedent to CONTRACTOR's being entitled to such payment appear to have been fulfilled in so far as it is ENGINEER's responsibility to observe the Work.
- C. However, by recommending any such payment ENGINEER will not thereby be deemed to have represented that:
1. exhaustive or continuous on-Site inspections have been made to check the quality or the quantity of the Work; or
 2. involved detailed inspections of the Work beyond the responsibilities specifically assigned to ENGINEER in the Contract; or
 3. there may not be other matters or issues between the parties that might entitle CONTRACTOR to be paid additionally by OWNER or entitle OWNER to withhold payment to CONTRACTOR.
- D. Neither ENGINEER's review of CONTRACTOR's Work for the purpose of recommending payments nor ENGINEER's recommendation of any payment, including final payment, will impose responsibility on ENGINEER:
1. to supervise, direct or control the Work;
 2. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto;
 3. for the failure of CONTRACTOR to comply with Laws and Regulations applicable to the furnishing or performance of Work;
 4. for any failure of CONTRACTOR to perform or furnish Work in accordance with the Contract Documents;
 5. to make any examination to ascertain how or for what purposes CONTRACTOR has used the moneys paid on account of the Contract Price;
 6. to determine that title to any Work, materials, or equipment has passed to OWNER free and clear of Liens.

- E. ENGINEER may refuse to recommend the whole or any part of any payment if, in ENGINEER's opinion, it would be incorrect to make such representations as stated above to OWNER. ENGINEER may also refuse to recommend any such payment, or, because of subsequently discovered evidence or the results of subsequent inspections or tests, nullify any such payment previously recommended to such extent as may be necessary in ENGINEER's opinion to protect OWNER from loss because:
1. the Work is defective, or completed Work has been damaged requiring correction or replacement;
 2. the Contract Price has been reduced because of Change Orders;
 3. OWNER has been required to correct defective Work in accordance with paragraph 13.09, or has accepted defective Work in accordance with paragraph 13.08;
 4. OWNER has been required to remove or remediate a Hazardous Environmental Condition for which CONTRACTOR is responsible;
 5. ENGINEER has actual knowledge of the occurrence of any of the events enumerated in paragraph 15.02.

14.05 Payment Becomes Due

- A. Thirty (30) days after presentation of the Application for Payment to OWNER with ENGINEER's recommendation, the amount recommended will (subject to the provisions of paragraph 14.05.B) become due, (or only if OWNER is a public agency, within 15 days after OWNER receives the funds which are to be provided by a department or agency of the federal or state government, whichever is later, or in accordance with any time periods required by any applicable statute, rule or regulation) and when due will be paid by OWNER to CONTRACTOR.
- B. OWNER may refuse to make payment of the full amount recommended by ENGINEER because:
1. Claims have been made against OWNER based on CONTRACTOR's conduct in the performance or furnishing of the Work, or OWNER has incurred costs, losses, or damages resulting from CONTRACTOR's conduct in the performance or furnishing of the Work, including but not limited to claims, costs, losses, or damages from workplace injuries, adjacent property damage, non-compliance with Laws and Regulations, and patent infringement;
 2. CONTRACTOR has failed to take reasonable and customary measures to avoid damage, delay, disruption, and interference with other work at or adjacent to the Site;
 3. CONTRACTOR has failed to provide and maintain required bonds or insurance;
 4. OWNER has been required to remove or remediate a Hazardous Environmental Condition for which CONTRACTOR is responsible;
 5. OWNER has incurred extra charges or engineering costs related to Submittal reviews, evaluations of proposed substitutes, tests and inspections, or return visits to manufacturing or assembly facilities;
 6. The Work is defective, requiring correction or replacement;

7. OWNER has been required to correct defective Work in accordance with paragraph 13.09, or has accepted defective Work pursuant to paragraph 13.08;
 8. The Contract Price has been reduced by Change Orders;
 9. An event has occurred that would constitute a default by CONTRACTOR and therefore justify a termination for cause;
 10. Liquidated or other damages have accrued as a result of CONTRACTOR's failure to achieve Milestones, Substantial Completion, or final completion of the Work;
 11. Liens have been filed in connection with the Work, except where CONTRACTOR has delivered a specific bond satisfactory to OWNER to secure the satisfaction and discharge of such Liens;
 12. there are other items as set forth in the Contract Documents entitling OWNER to a set off against the amount recommended; or
 13. OWNER has actual knowledge of the occurrence of any of the events enumerated in paragraphs 14.04.E.1 through 14.04.E.5.
- C. If OWNER refuses to make payment of the full amount recommended by ENGINEER, OWNER will give CONTRACTOR immediate written notice (with a copy to ENGINEER) stating the reasons for such action and promptly pay CONTRACTOR any amount remaining after deduction of the amount so withheld. OWNER shall promptly pay CONTRACTOR the amount so withheld, or any adjustment thereto agreed to by OWNER and CONTRACTOR, when CONTRACTOR corrects, to OWNER's satisfaction, the reasons for such action. The reduction imposed shall be binding on CONTRACTOR unless CONTRACTOR duly submits a Change Proposal contesting the reduction.
- D. If it is subsequently determined that OWNER's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by paragraph 14.05.

14.06 CONTRACTOR's Warranty of Title

- A. CONTRACTOR warrants and guarantees that title to all Work, materials and equipment covered by any Application for Payment, whether incorporated in the Project or not, will pass to OWNER at the time of payment free and clear of all Liens, claims, security interests and encumbrances (hereafter in these General Conditions referred to as "Liens").

14.07 Substantial Completion

- A. When CONTRACTOR considers the entire Work ready for its intended use CONTRACTOR shall notify OWNER and ENGINEER in writing that the entire Work is substantially complete and request that ENGINEER issue a Certificate of Substantial Completion. CONTRACTOR shall at the same time submit to OWNER and ENGINEER an initial draft of punch list items to be completed or corrected before final payment.
- B. Promptly after CONTRACTOR's notification, OWNER, CONTRACTOR, and ENGINEER shall make an inspection of the Work to determine the status of completion. If ENGINEER does not consider the Work substantially complete, ENGINEER will notify CONTRACTOR in writing giving the reasons therefor.

- C. Once ENGINEER considers the Work substantially complete, ENGINEER will deliver to OWNER a preliminary Certificate of Substantial Completion which shall fix the date of Substantial Completion. ENGINEER shall attach to the certificate a punch list of items to be completed or corrected before final payment. OWNER shall have 7 days after receipt of the preliminary certificate during which to make written objection to ENGINEER as to any provisions of the certificate or attached punch list. If, after considering the objections to the provisions of the preliminary certificate, ENGINEER concludes that the Work is not substantially complete, ENGINEER will, within 14 days after submission of the preliminary certificate to OWNER, notify CONTRACTOR in writing that the Work is not substantially complete, stating the reasons therefore. If OWNER does not object to the provisions of the certificate, or if despite consideration of OWNER's objections ENGINEER concludes that the Work is substantially complete, then ENGINEER will, within said 14 days, execute and deliver to OWNER and CONTRACTOR a final Certificate of Substantial Completion (with a revised punch list of items to be completed or corrected) reflecting such changes from the preliminary certificate as ENGINEER believes justified after consideration of any objections from OWNER.
- D. At the time of receipt of the preliminary Certificate of Substantial Completion, OWNER and CONTRACTOR will confer regarding OWNER's use or occupancy of the Work following Substantial Completion, review the builder's risk insurance policy with respect to the end of the builder's risk coverage, and confirm the transition to coverage of the Work under a permanent property insurance policy held by OWNER. Unless OWNER and CONTRACTOR agree otherwise in writing, OWNER shall bear responsibility for security, operation, protection of the Work, property insurance, maintenance, heat, and utilities upon OWNER's use or occupancy of the Work.
- E. After Substantial Completion the CONTRACTOR shall promptly begin work on the punch list of items to be completed or corrected prior to final payment. In appropriate cases CONTRACTOR may submit monthly Applications for Payment for completed punch list items, following the progress payment procedures set forth above.
- F. OWNER shall have the right to exclude CONTRACTOR from the Site after the date of Substantial Completion subject to allowing CONTRACTOR reasonable access to remove its property and complete or correct items on the punch list.

14.08 Partial Utilization

- A. Use by OWNER of completed portions of the Work may be accomplished prior to Substantial Completion of all the Work subject to the following:
 - 1. OWNER at any time may request CONTRACTOR in writing to permit OWNER to use any part of the Work which OWNER believes to be substantially complete and which may be so used without significant interference with construction of the other parts of the Work. If CONTRACTOR agrees, CONTRACTOR will certify to OWNER and ENGINEER that said part of the Work is substantially complete and request ENGINEER to issue a certificate of Substantial Completion for that part of the Work. Within a reasonable time thereafter OWNER, CONTRACTOR and ENGINEER shall make an inspection of that part of the Work to determine its status of completion.

- a. If ENGINEER does not consider that part of the Work to be substantially complete, ENGINEER will notify OWNER and CONTRACTOR in writing giving his reasons therefor.
 - b. If ENGINEER considers that part of the Work to be substantially complete, ENGINEER will execute and deliver to OWNER and CONTRACTOR a certificate to that effect, fixing the date of Substantial Completion for that part of the Work, attaching thereto a punch list of items to be completed or corrected before final payment.
2. Prior to issuing a certificate of Substantial Completion for that part of the Work, ENGINEER will deliver to OWNER and CONTRACTOR a written recommendation as to the division of responsibilities pending final payment between OWNER and CONTRACTOR with respect to security, operation, safety, maintenance, utilities and insurance for that part of the Work, which shall become binding upon OWNER and CONTRACTOR at the time of issuing the definitive certificate of Substantial Completion for that part of the Work unless OWNER and CONTRACTOR shall have otherwise agreed in writing and so informed ENGINEER.
3. OWNER shall have the right to exclude CONTRACTOR from any part of the Work which ENGINEER has so certified to be substantially complete, but OWNER shall allow CONTRACTOR reasonable access to complete or correct items on the punch list.
4. In lieu of the issuance of a certificate of Substantial Completion as to part of the Work, OWNER may take over operation of a facility constituting part of the Work whether or not it is Substantially Complete if such facility is functionally and separately usable; provided that prior to any such takeover, OWNER and CONTRACTOR have agreed as to the division of responsibilities between OWNER and CONTRACTOR for security, operation, safety, maintenance, correction period, heat, utilities and insurance with respect to such facility.

14.09 Final Inspection

- A. Upon written notice from CONTRACTOR that the Work is complete, ENGINEER will make a final inspection with OWNER and CONTRACTOR and will notify CONTRACTOR in writing of all particulars in which this inspection reveals that the Work is incomplete or defective. CONTRACTOR shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

14.10 Final Application for Payment

- A. After CONTRACTOR has completed all corrections to the satisfaction of ENGINEER and delivered all maintenance and operating instructions, schedules, guarantees, Bonds, certificates of inspection, marked up record documents and other documents (all as required by the Contract Documents), and after ENGINEER has indicated that the Work is acceptable, subject to the provisions of paragraph 14.13, CONTRACTOR may make application for final payment following the procedure for progress payments.
- B. The final Application for Payment shall be accompanied by all documentation called for in the Contract Documents and such other data and schedules as ENGINEER may reasonably require, consent of Surety, if any, to final payment, together with complete and legally effective releases or waivers, satisfactory to OWNER, of all Liens arising out of or filed in connection with the Work.

- C. In lieu of the releases or waivers of Lien, if approved by OWNER, CONTRACTOR may furnish receipts or releases in full; an affidavit of CONTRACTOR that the releases and receipts include all labor, services, material and equipment for which a Lien could be filed, and that all payrolls, material and equipment bills, and other indebtedness connected with the Work for which OWNER or his property might in any way be responsible, have been paid or otherwise satisfied.
- D. If any Subcontractor, manufacturer, fabricator, Supplier or distributor fails to furnish a release or receipt in full, CONTRACTOR may furnish a Bond or other collateral satisfactory to OWNER to indemnify OWNER against any Claim or Lien.

14.11 Final Payment and Acceptance

- A. If, on the basis of ENGINEER's observation of the Work during construction and final inspection, and ENGINEER's review of the final Application for Payment and accompanying documentation (all as required by the Contract Documents), ENGINEER is satisfied that to the best of ENGINEER's knowledge, information and belief as a design professional that the Work has been completed and CONTRACTOR has fulfilled all of his obligations under the Contract Documents, ENGINEER will, within 10 days after receipt of the final Application for Payment, indicate in writing ENGINEER's Certificate for Payment and present the application to OWNER for payment. At that time ENGINEER will give written notice to OWNER and CONTRACTOR that the Work is acceptable subject to the provisions of paragraph 14.13.
- B. Otherwise, ENGINEER will return the Application to CONTRACTOR, indicating in writing the reasons for refusing to recommend final payment, in which case CONTRACTOR shall make the necessary corrections and resubmit the Application.
- C. If the Application and accompanying documentation are appropriate as to form and substance, OWNER shall, within 45 days (or within the time period required by any applicable statute, rule or regulation) after receipt thereof pay CONTRACTOR the amount recommended by ENGINEER less any amounts of OWNER claimed set-offs allowed under the Contract Documents, including but not limited to any applicable liquidated damages as determined by OWNER. If OWNER rejects the Application, OWNER shall do so in writing stating the appropriate sections of the Contract Documents upon which the rejection is based. CONTRACTOR may take the necessary remedial actions and resubmit the Application.

14.12 Final Completion Delayed

- A. If, through no fault of CONTRACTOR, final completion of the Work is significantly delayed, and if ENGINEER so confirms, OWNER shall, upon receipt of CONTRACTOR's final Application for Payment and recommendation of ENGINEER, and without terminating the Agreement, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by OWNER for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if Bonds have been furnished as required in paragraph 5.01, the written consent of the Surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by CONTRACTOR to ENGINEER with the Application for such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

14.13 Waiver of Claims

- A. The making and acceptance of final payment shall constitute:
 - 1. a waiver of all Claims by OWNER against CONTRACTOR, except Claims arising from unsettled Liens, from defective Work appearing after final inspection pursuant to paragraph 14.09, or from failure to comply with the Contract Documents or the terms of any special guarantees specified therein; and shall not constitute a waiver by OWNER of any rights in respect of CONTRACTOR's existing or continuing obligations under the Contract Documents; and,
 - 2. a waiver of all Claims by CONTRACTOR against OWNER other than those previously made in writing and still pending in accordance with Article 16.

14.14 Late Payments

- A. All monies not paid when due hereunder, except monies involving Federal and/or State Loans, Grants, or other sources which are delinquent because of no fault of the OWNER, shall bear interest at the maximum rate allowed by law at the time and place of the Project.

Article 15 Suspension of Work and Termination

15.01 OWNER May Suspend Work

- A. OWNER may, at any time and without cause, suspend the Work or any portion thereof for a period as OWNER may deem necessary by notice in writing to CONTRACTOR and ENGINEER. If it should become necessary to stop work for an indefinite period, CONTRACTOR shall store all materials in such manner that they will not become an obstruction, nor become damaged in any way, and CONTRACTOR shall take every precaution to prevent damage or deterioration of the Work performed; provide suitable drainage by opening ditches and drains, and erect temporary structures where necessary. CONTRACTOR may request an increase in the Contract Price or an extension of the Contract Time, or both, directly attributable to any suspension if he makes a Claim therefor as provided in paragraph 11.01.

15.02 OWNER May Terminate for Cause

- A. The occurrence of any one or more of the following events will constitute a default by CONTRACTOR and justify termination for cause:
 - 1. CONTRACTOR commences a voluntary case under any chapter of the Bankruptcy Code (Title 11, United States Code), as now or hereafter in effect, or if CONTRACTOR takes any equivalent or similar action by filing a petition or otherwise under any other federal or state law in effect at such time;
 - 2. a petition is filed against CONTRACTOR under any chapter of the Bankruptcy Code as now or hereinafter in effect at the time of filing, or if a petition is filed seeking any such equivalent or similar relief against CONTRACTOR under any other federal or state law in effect at the time relating to bankruptcy or insolvency;
 - 3. CONTRACTOR makes a general assignment for the benefit of creditors;

4. a trustee, receiver, custodian or agent of CONTRACTOR is appointed under applicable law or under contract, whose appointment or authority to take charge of property of CONTRACTOR is for the purpose of enforcing a Lien against such property or for the purpose of general administration of such property for the benefit of CONTRACTOR's creditors;
 5. CONTRACTOR admits in writing an inability to pay its debts generally as they become due;
 6. CONTRACTOR persistently fails to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the Progress Schedule established under paragraph 2.05 as revised from time to time);
 7. CONTRACTOR disregards Laws and Regulations of any public body having jurisdiction;
 8. CONTRACTOR disregards the authority of ENGINEER or OWNER; or,
 9. CONTRACTOR otherwise violates any provisions of the Contract Documents.
- B. OWNER may, after giving CONTRACTOR (and the Surety, if there be one) 7 days' written notice, and to the extent permitted by Laws and Regulations, terminate the services of CONTRACTOR, exclude CONTRACTOR from the Site, take possession of the Work and of all CONTRACTOR's tools, appliances, construction equipment, and machinery at the site and use the same to the full extent they could be used by CONTRACTOR (without liability to CONTRACTOR for trespass or conversion), incorporate in the Work all materials and equipment stored at the Site or for which OWNER has paid CONTRACTOR but which are stored elsewhere, finish the Work as OWNER may deem expedient, and/or enforce the rights available to OWNER under any applicable Performance Bond.
- C. In such case, CONTRACTOR shall not be entitled to receive any further payment until the Work is finished. If the unpaid balance of the Contract Price exceeds all claims, costs, losses, damages and expenses sustained by OWNER arising out of or resulting from completing the Work, such excess will be paid to CONTRACTOR. If such claims, costs, losses, damages and expenses exceed such unpaid balance, CONTRACTOR shall pay the difference to OWNER. Such claims, costs, losses, damages and expenses incurred by OWNER will be reviewed as to reasonableness by ENGINEER and when so approved, incorporated in a Change Order, but when exercising any rights or remedies under this paragraph, OWNER shall not be required to obtain the lowest price for the Work performed.
- D. Where CONTRACTOR's services have been so terminated by OWNER, the termination shall not affect any rights or remedies of OWNER against CONTRACTOR or its Surety then existing or which may thereafter accrue. Any retention or payment of monies due CONTRACTOR by OWNER will not release CONTRACTOR from liability.

15.03 Termination for Convenience

- A. Upon 7 days' written notice to CONTRACTOR and ENGINEER, OWNER may, without cause and without prejudice to any other right or remedy, elect to terminate the Agreement. In such case, CONTRACTOR shall be paid (without duplication of any items):

1. for completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination;
 2. for actual expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials or equipment as required by the Contract Documents in connection with uncompleted Work; and
 3. for reasonable expenses directly attributable to protecting work as a result of termination.
- B. CONTRACTOR shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.
- C. Upon such termination, CONTRACTOR shall:
1. Immediately discontinue Work on the date and to the extent specified in the notice except to the extent necessary to protect Work in place;
 2. Place no further orders for materials, services, or facilities, other than as may be necessary or required for completion of such portion of Work under the Contract that is not terminated;
 3. Promptly make every reasonable effort to obtain cancellation upon terms reasonably satisfactory to OWNER of all purchase orders and subcontracts to the extent they relate to the performance of Work terminated or assign to OWNER those orders and subcontracts and revoke agreements specified in such notice;
 4. Reasonably assist OWNER, as specifically requested in writing, in the maintenance, protection and disposition of property acquired by OWNER under the Contract Documents, as may be necessary;
 5. Complete performance of any Work which is not terminated; and
 6. Deliver to OWNER an affidavit regarding the identity of potential unpaid Subcontractors or Suppliers and the amounts due to each.

15.04 CONTRACTOR May Stop Work or Terminate

- A. If OWNER has failed to pay CONTRACTOR any sum finally determined to be due in accordance with the time limits specified in paragraph 14.05, CONTRACTOR may upon 7 days' written notice to OWNER and ENGINEER, stop the Work until payment of all amounts then due.
- B. If through no act or fault of CONTRACTOR, the Work is suspended for a period of more than 90 days by OWNER, or under an order of court or other public authority, then CONTRACTOR may, upon 7 days written notice to OWNER and ENGINEER and provided OWNER or ENGINEER does not remedy such suspension or failure within that time, terminate the Agreement and recover from OWNER payment on the same terms as provided in paragraph 15.03.
- C. The provisions of this paragraph 15.04 shall not relieve CONTRACTOR of his obligations under paragraph 6.22 to carry on the Work in accordance with the Progress Schedule and without delay during disputes and disagreements with OWNER.

Article 16 Final Resolution of Disputes

16.01 Methods and Procedures

- A. Disputes Subject to Final Resolution: The following disputed matters are subject to final resolution under the provisions of this Article:
 - 1. A timely appeal of an approval in part and denial in part of a Claim, or of a denial in full; and
 - 2. Disputes between OWNER and CONTRACTOR concerning the Work or obligations under the Contract Documents and arising after final payment has been made.
- B. Final Resolution of Disputes: For any dispute subject to resolution under this Article, OWNER or CONTRACTOR may:
 - 1. elect in writing to invoke the dispute resolution process provided for in the Supplementary Conditions; or
 - 2. agree with the other party to submit the dispute to another dispute resolution process; or
 - 3. if no dispute resolution process is provided for in the Supplementary Conditions or mutually agreed to, the following dispute resolution process shall be followed:
 - a. The parties shall submit the dispute to mediation under the mediation procedures outlined in the Construction Industry Arbitration Rules and Mediation Procedures of the American Arbitration Rules.
 - b. If the dispute is not resolved by mediation, the parties shall proceed to resolve the dispute by arbitration in accordance with the Construction Industry Arbitration Rules and Mediation Procedures of the American Arbitration Association. The decision of the arbitrator(s) shall be final and binding and is enforceable in a court of competent jurisdiction.

Article 17 Miscellaneous

17.01 Giving Notice

- A. Whenever any provision of the Contract Documents requires the giving of written notice to OWNER, ENGINEER, or CONTRACTOR, it shall be deemed to have been validly given only if delivered:
 - 1. in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended;
 - 2. by registered or certified mail postage prepaid to, the last business address known to the giver of the notice;
 - 3. or delivered in person to such person by a commercial courier service or otherwise to the recipient's place of business; or
 - 4. by secure file transfer with receipt documentation or other document control software.

17.02 Computation of Time

- A. When any period of time is referred to in the Contract Documents by days, it shall be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday, or on a day made a legal holiday by the Law of the applicable jurisdiction, such day shall be omitted from the computation.

17.03 General

- A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and shall not be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Law or Regulation, by special warranty or guarantee, or by other provisions of the Contract Documents. The provisions of this paragraph shall be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right and remedy to which they apply.
- B. All representations, warranties and guarantees made in the Contract Documents shall survive final payment and termination or completion of this Agreement.

17.04 Professional Fees and Court Costs Included

- A. Whenever reference is made to “claims, costs, losses, damages and expenses,” it shall include in each case, but not be limited to, all fees and charges of engineers, architects, attorneys and other professionals and all court or arbitration or other dispute resolution costs.

17.05 Nondiscrimination of Employment

- A. The CONTRACTOR shall covenant and agree not to discriminate against any employee or applicant for employment, to be employed in the performance of this Contract, with respect to his hire, tenure, terms, conditions or privileges of employment, or any matter directly or indirectly related to employment, because of race, color, sex, age, religion, national origin or ancestry, height, weight, or marital status, or any other classification protected by law, and to require a similar covenant on the part of any Subcontractor employed in the performance of the Contract.

17.06 Post Completion Date Engineering and Inspection Costs

- A. All engineering and inspection costs incurred after the specified completion date shall be paid by CONTRACTOR to OWNER prior to final payment authorization. However, CONTRACTOR shall not be charged with any post completion date engineering and inspection costs when the delay in completion of the Work is due to the following and CONTRACTOR has promptly given written notice of such delay to OWNER or ENGINEER:
 - 1. to any preference, priority or allocation order duly issued by OWNER;
 - 2. to unforeseeable causes beyond the control and without the fault or negligence of CONTRACTOR, including but not restricted to, acts of God, or of the public enemy, acts of OWNER, acts of another contractor in the performance of a Contract with OWNER, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, and abnormal and unforeseeable weather; and,
 - 3. to any delays of Subcontractors or Suppliers occasioned by any of the causes specified in this Article.

- B. Charges after the specified completion date shall be made at such times and in such amounts as ENGINEER shall invoice OWNER, provided, however said charges shall be in accordance with ENGINEER's current rate schedule at the time the costs are incurred. Engineering and inspection costs so incurred shall be deducted from CONTRACTOR's progress payments.

17.07 Waiver of Consequential Damages

- A. CONTRACTOR and OWNER waive Claims against each other for consequential damages arising out of or relating to this Contract or the Work. This mutual waiver includes but is not limited to:
 - 1. damages incurred by OWNER for rental expenses, for losses of use, income, profit, financing, business and reputation, and for loss of management or employee productivity or of the services of such persons; and
 - 2. damages incurred by CONTRACTOR for principal office expenses including the compensation of personnel stationed there, for losses of financing, business and reputation, and for loss of profit in connection with any other project or anticipated project.
- B. This mutual waiver is applicable, without limitation, to all consequential damages due to either party's termination or default. Nothing contained in this Section shall be deemed to preclude an award of liquidated damages, when applicable, in accordance with the requirements of the Contract Documents. CONTRACTOR also waives any Claim for consequential damages against ENGINEER where such Claims arise out of or relate in any way to the Project or the Contract Documents.

17.08 No Waiver

- A. A party's non-enforcement of any provision shall not constitute a waiver of that provision, nor shall it affect the enforceability of that provision or of the remainder of this Contract.

17.09 Controlling Law

- A. This Contract is to be governed by the Law of the state in which the Project is located.

17.10 Headings

- A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

End of Section

Section 00 7300 Supplementary Conditions

These Supplementary Conditions amend or supplement Section 00 7200, General Conditions, as indicated below. All provisions which are not amended or supplemented by this section remain in full force and effect. The terms used in these Supplementary Conditions have the meanings assigned to them in the General Conditions.

SGC-4.02 Physical Conditions - Investigations and Reports

Add a new paragraph immediately after the first paragraph of paragraphs 4.02 of the General Conditions, which is to read as follows:

In the preparation of Plans and Specifications, ENGINEER has relied upon the following reports and tests of subsurface and latent physical conditions at the site or otherwise affecting cost, progress or performance of the Work:

Copies of the following reports and/or tests are attached as Exhibits:

Exhibit 2 - Geotechnical Report titled "Geotechnical Exploration, Proposed Dewatering Building, Flint Wastewater Treatment Plant" dated February 18, 2018, prepared by Geotrans, consisting of 31 pages with 2 boring logs. The "technical data" contained in such report upon which CONTRACTOR may rely is the boring logs and report.

SGC-5.03.D Additional Insured

Add the following language at the end of Article 5.03.D. of the General Conditions:

The name insured on OWNER's and CONTRACTOR's Protective Policy shall be: The City of Flint

Additional named insured on OWNER's and CONTRACTOR's Protective Policy shall include:

1. Wade Trim, Inc.
2. Hubbell, Roth & Clark, Inc.
3. GeoTrans

SGC-5.04 Limits of Liability

The required limits of liability for insurance coverages requested in Section 5.03 shall be not less than the following:

SGC-5.04.A Worker's Compensation

Coverage A – Compensation	Statutory
Coverage B – Employer's Liability	
Each Accident	\$ 100,000
Disease – Policy Limit	\$ 100,000
Disease – Each Employee	\$ 100,000

SGC-5.04.B Comprehensive General Liability

General Aggregate	\$2,000,000
Products – Com/Ops Aggregate	\$2,000,000
Personal and Advertising Injury	\$1,000,000
Each Occurrence	\$1,000,000
Fire Damage (any one fire)	\$ 50,000
Medical Expense (any one person)	\$ 5,000

SGC-5.04.C Comprehensive Automobile Liability

Bodily Injury	\$ 500,000
Property Damage	\$ 200,000
or combined single limit	\$1,000,000

SGC-5.04.D Owner's Protective – Coverage shall be Occurrence Form

General Aggregate	\$1,000,000
Each Occurrence	\$1,000,000

SGC-5.04.F. Umbrella or Excess Liability

Each Occurrence	\$2,000,000
Aggregate	\$2,000,000

SGC-18 Dispute Resolution

Dispute resolution, if applicable, are referenced in the General Conditions. The requirements for dispute resolution should be included herein:

Article 18 Dispute Resolution**18.01 Methods and Procedures**

- A. Either OWNER or CONTRACTOR may request mediation of any Claim submitted to ENGINEER for a decision under Paragraph 10.05 before such decision becomes final and binding. The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Effective Date of the Agreement. The request for mediation shall be submitted in writing to the American Arbitration Association and the other party to the Contract. Timely submission of the request shall stay the effect of Paragraph 11.01.
- B. OWNER and CONTRACTOR shall participate in the mediation process in good faith. The process shall be concluded within sixty (60) days of filing of the request. The date of termination of the mediation shall be determined by application of the mediation rules referenced above.
- C. If the Claim is not resolved by mediation, ENGINEER's action under Paragraph 11.01 or a denial pursuant to Paragraphs 11.01 shall become final and binding 30 days after termination of the mediation unless, within that time period, OWNER or CONTRACTOR:
 - 1. elects in writing to demand arbitration of the Claim, pursuant to Paragraph 18.02; or
 - 2. agrees with the other party to submit the Claim to another dispute resolution process.

18.02 Arbitration

- A. Claims or counterclaims, disputes, or other matters in question between OWNER and CONTRACTOR arising out of or relating to the Contract Documents or the breach thereof (except for Claims which have been waived by the making or acceptance of final payment as provided by Paragraph 14.01) including but not limited to those not resolved under the provisions of Paragraphs 18.01 will be decided by arbitration in accordance with the rules of the American Arbitration Association, subject to the conditions and limitations of this Paragraph. This agreement to arbitrate and any other agreement or consent to arbitrate entered into will be specifically enforceable under the prevailing law of any court having jurisdiction.

- B. The demand for arbitration will be filed in writing with the other party to the Contract and with the selected arbitrator or arbitration provider, and a copy will be sent to ENGINEER for information. The demand for arbitration will be made within the 30-day period specified in Paragraph 18.01, and in all other cases within a reasonable time after the Claim or counterclaim, dispute, or other matter in question has arisen, and in no event shall any such demand be made after the date when institution of legal or equitable proceedings based on such Claim or other dispute or matter in question would be barred by the applicable statute of limitations.
- C. No arbitration arising out of or relating to the Contract Documents shall include by consolidation, joinder, or in any other manner any other individual or entity (including ENGINEER, and ENGINEER's consultants and the officers, directors, partners, agents, employees or consultants of any of them) who is not a party to this Contract unless:
 - 1. the inclusion of such other individual or entity is necessary if complete relief is to be afforded among those who are already parties to the arbitration; and
 - 2. such other individual or entity is substantially involved in a question of law or fact which is common to those who are already parties to the arbitration and which will arise in such proceedings.
- D. The award rendered by the arbitrator(s) shall be consistent with the agreement of the parties, in writing, and include:
 - 1. a concise breakdown of the award;
 - 2. a written explanation of the award specifically citing the Contract Document provisions deemed applicable and relied on in making the award.
- E. The award will be final. Judgment may be entered upon it in any court having jurisdiction thereof, and it will not be subject to modification or appeal, subject to provisions of the Controlling Law relating to vacating or modifying an arbitral award.
- F. The fees and expenses of the arbitrators and any arbitration service shall be shared equally by OWNER and CONTRACTOR.

SGC-19 Liquidated Damages

Liquidated damages, if applicable, are referenced in the Proposal and Agreement. The requirements for liquidated damages should be included herein.

Article 19 Liquidated Damages

- A. If CONTRACTOR shall fail to Substantially Complete the Work within the Contract Time, or extension of time granted by OWNER, then CONTRACTOR will pay to OWNER the amount for liquidated damages as specified in the Agreement for each calendar day that CONTRACTOR shall be in default after the time stipulated in the Contract Documents. The liquidated damages charged shall be deducted from CONTRACTOR's progress payments.
- B. CONTRACTOR shall not be charged with liquidated damages or any excess cost when the delay in Substantial Completion of the Work is due to the following and CONTRACTOR has given written notice of such delay within seven (7) calendar days to OWNER or ENGINEER.
 - 1. To any preference, priority or allocation order duly issued by the OWNER.

2. To unforeseeable causes beyond the control and without the fault or negligence of the CONTRACTOR, including but not restricted to, acts of God, or of the public enemy, acts of the OWNER, acts of another CONTRACTOR in the performance of a Contract with the OWNER, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, and abnormal and unforeseeable weather; and
3. To any delays of subcontractors occasioned by any of the causes specified in Items A and B of this Article.

End of Section

Division 01
General Requirements

Section 01 1100

Summary of Work

Part 1 General

1.01 Work Covered by Contract Documents

- A. This Project includes bypassing of the Influent Structure, internal and external concrete repair of the Influent Structure, severing and plugging the existing interconnection between Grit Battery A and B, installation of sluice gates in the Influent Structure, installation of cured-in-place pipe and a flow meter on the Grit Battery A influent piping, construction of a new grit classifier building for Grit Battery A, as well as the removal and installation of new grit pumps, piping, valves, installation of new grit classifier, rehabilitation of existing grit tanks and associated electrical improvements, SCADA, concrete, demolition and sitework as shown in the Contract Drawings and specified herein.

1.02 Work by Others

- A. There is no other work in the Project area, known to OWNER, which would affect this Contract.

1.03 Working Space

- A. 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, CONTRACTOR may obtain such space on privately owned property at his own expense, by agreement with the property owner thereof. CONTRACTOR shall provide OWNER with a copy of the written permission from the private property owner prior to occupying the property.

1.04 Work Within Public Streets or Land

- A. Where the centerline of the proposed improvement is within the public street or land, CONTRACTOR shall confine his operations to within the public street or land unless easements have been acquired. It shall be CONTRACTOR's responsibility to use such methods and/or materials, including sheeting, so as to prevent any portion of the excavation from encroaching on private property. This shall not preclude CONTRACTOR from obtaining the right to encroach on private land in accord with the foregoing article "Working Space."
- B. Signing and barricading shall be done in accordance with current edition of the Michigan Manual of Uniform Traffic Control Devices (MMUTCD) as issued by the Michigan Department of Transportation (MDOT).

1.05 Easements

- A. In certain instances, OWNER may have acquired certain permanent easements and construction easements for the contractor's use in constructing the work. CONTRACTOR shall confine work operations to these easements except as noted under Article 1.03 of this Section.

1.06 Locating Work

- A. CONTRACTOR shall accurately locate the work from reference points established by OWNER along the surface of the ground and the line of work.

1.07 Soil Conditions

- A. CONTRACTOR 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 OWNER. This shall apply whether or not borings are shown on the drawings.
- B. OWNER does not guarantee that the ground encountered during construction will conform with any boring information furnished herein.
- C. 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 prospective Bidders.

1.08 Survey Monuments

- A. Monuments or other recognized property boundary markers at street intersections, section corners, acreage or lot corners, and right of way lines shall be preserved and protected.
- B. Where such monuments or markers must be removed during construction, OWNER shall be notified, and CONTRACTOR shall make all necessary arrangements with a land surveyor registered in the State of Michigan to have these monuments or markers properly witnessed prior to disturbance or removal and later reset by the registered land surveyor at no cost to OWNER.

1.09 Trench Backfill

- A. CONTRACTOR, as such and as Bidder, shall carefully review the Contract Documents and shall determine the extent of trench backfill requirements.
- B. The type and method of backfilling is dependent on its locations and function and shall conform with the following requirements. OWNER will supply field observation on the backfill compaction requirements.
- C. Backfilling of trenches in the shoulder area and under private gravel drives shall be carried to within 6 inches of the existing surface as specified under Trench A or Trench B as required. The shoulder shall be defined herein as the area within ten feet of the pavement edge, or the width of the existing graveled shoulder, whichever is the lesser. The remaining depth shall be backfilled with 6 inches of compacted 21AA aggregate. Backfilling of trenches crossing gravel roads or streets shall be carried to within 8 inches of the existing surface and the remaining depth shall be backfilled with 8 inches of compacted 21AA limestone aggregate. Compaction shall be performed by a pneumatic tired roller or a vibratory compactor until the compaction requirements as required for Trench A or Trench B and as detailed in the following paragraphs are met.
- D. The requirements as specified herein are in addition to the conditions provided for under permit granted by the local agency, MDOT, or agency with jurisdiction.

E. Trench A:

1. Trenches under graveled, slag or hard surfaced roads, pavements, hard surfaced parking lots and driveways, sidewalks, curbs and where the trench edge is within 3 feet of a pavement shall be backfilled with bank run sand meeting the requirements of Granular Material, MDOT Class II.
2. Material shall be placed by the Controlled Density Method or other effective means having the approval of the Engineer and is to be compacted to 95 percent of maximum unit weight as determined by ASTM D-1557 Modified Proctor.
3. Trenches under pavement to be constructed in the near future, as noted or shown on the drawings, shall be backfilled with MDOT Class II Granular Material, meeting the requirements of Table 902-3 Grading Requirements for Granular Materials in MDOT's Standard Specifications for Construction.

F. Trench B:

1. Trench B shall be used where called for on the drawings and where the trench crosses slag or gravel drives, shoulders, or parking lots whether called for on the drawings or not.
2. Trenches shall be backfilled with granular material, MDOT Class II to a point 12 inches above the pipe for diameters less than 24 inches and up to the spring line with materials meeting the requirements of the 1996 MDOT Table 902-2, Class 34R for diameters 24 inches or larger. This portion of the backfill is to be placed in layers not exceeding 6 inches in depth and shall be thoroughly compacted by mechanical tamping to not less than 95% of maximum unit weight utilizing ASTM D-1557 Modified Proctor. Remainder of the backfill shall be made with suitable excavated material (excluding blue and gray clays, peat, muck, marl or other organic materials) placed in 1-foot layers with each layer being thoroughly compacted by approved mechanical methods, or other effective means having the approval of ENGINEER, to a density of 90% of maximum unit weight utilizing ASTM D-1557 Modified Proctor.

1.10 Maintenance and Restoration of Pavements, Road Surfaces, Structures and Trench Backfill

- A. Where trenches cross existing improved roadways or drives or where the trench parallels an existing improved roadway which is disturbed by CONTRACTOR's operations, CONTRACTOR shall consolidate the trench backfill and shall place a temporary gravel fill of at least 8 inches and meeting 21AA Aggregate Gradation. CONTRACTOR shall, during the life of the contract, maintain the same in good condition with additional gravel as settling takes place.
- B. Structures, including curbing, walks, paving, gravel, or street road surfaces, etc., that may be damaged or destroyed by CONTRACTOR's operations, shall be repaired and replaced by him at his own expense.
- C. In restoring pavement, a saw shall be used and a cut equal to at least 3/4 of the thickness of the existing pavement shall be made on each side of the part to be restored, with the exception of expansion joints that shall be saw cut the full depth of the pavement. Concrete shall be 3500 psi, using 6 sacks of cement per cubic yard of concrete, unless otherwise required.

- D. If the pavement removed had an asphaltic concrete surface, the surface shall be removed to a distance one foot beyond the limits of the removed concrete pavement. Butt joints in asphaltic concrete removal shall be prepared by sawing through the total depth of asphaltic concrete. The surface shall be replaced with a nominal four inches of MDOT bituminous surface mixture as required by OWNER and meeting the requirements of the MDOT as to materials and method of replacement at no extra cost to OWNER.
- E. Trenches shall be backfilled to the requirement of "Trench A" or "Trench B" specifications as described in this Section and as specified on plans and profiles. After completion of backfill, the work area shall be restored as noted herein.

1.11 Road Permits

- A. 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 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.

1.12 Road Detours

- A. CONTRACTOR shall provide and maintain all temporary roadways as required for work operations or otherwise specified or shown on the drawings at no extra cost to OWNER.

1.13 Protection of the Public

- A. 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 OWNER at no extra cost to OWNER.

1.14 Barricades and Protection

- A. CONTRACTOR shall provide and maintain in good repair, all barricades, guard railings, etc., as required for the protection of the workers, 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 OWNER.

1.15 Maintenance of Traffic

- A. During the progress of the work, the contractor shall accommodate both vehicular (seepage trucks) 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 MMUTCD. Access to fire hydrants and water valves shall always be maintained. CONTRACTOR's truck and equipment operations on public streets shall be governed by local 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 OWNER. Wherever possible, 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 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 OWNER. In the event of 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 OWNER, or at his insistence, shall serve in no way to release CONTRACTOR from his liability for the safety of the traveling public.
- D. CONTRACTOR shall provide flagmen, warning lights, signs, fencing and barricades necessary to direct and protect vehicular and pedestrian traffic at no extra cost to OWNER.
- E. 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.

1.16 Sodding

- A. Where called for in the specifications or on the Contract Drawings, or as directed by ENGINEER, CONTRACTOR shall furnish labor and material and place Grade A sod to the finished grade shown, or to conform with existing grades, and provide a smooth and uniform surface to meet existing ground surface.
 - 1. Sod shall be densely rooted grass to match the adjacent lawn, free from noxious weeds and reasonably free from other weeds. Sod shall be not less than 2 inches thick, cut in strips not less than 10 inches wide by 18 inches long.
- B. The area to be sodded shall be made smooth and shall be covered with not less than 2 inches of approved top soil screened to remove all debris uniformly spread over the scarified ground surface.
- C. Sod shall be moist and shall be laid in a moist earth bed. Pegs shall be used where required to hold the sod in place.
- D. Sod shall not be placed during a drought nor during the period from June 1 to September 15. Sod to be kept moist by CONTRACTOR for 14 days to ensure growth.
- E. The cost of providing for and meeting these requirements shall be incidental to the Work as bid, unless otherwise noted.

1.17 Final Cleanup, Grading, Topsoil and Seeding

- A. Upon completion of construction and before final payment is made, CONTRACTOR shall restore the working area to as clean a condition as existed before construction operations started.

- B. CONTRACTOR shall go over the entire area and regrade and fill any areas that may have settled, including fills made from excess excavated materials and all other areas that may have been disturbed during construction operations.
- C. Where established lawn or grass areas have been disturbed by CONTRACTOR's operations, and in the location where the excavated soils have been stockpiled and graded, CONTRACTOR shall provide, not less than the minimum depth of approved top soil and shall grade, seed, fertilize and mulch the areas as required by ENGINEER.
- D. Seeded areas are to be kept moist for 14 days to ensure growth.
- E. The cost of providing for and meeting these requirements shall be incidental to the Work as bid, unless otherwise noted.

1.18 Existing Structures and Utilities

- A. Certain underground structures and utilities have been shown on the Contract Drawings as an aid to CONTRACTOR; neither OWNER nor ENGINEER guarantee their location or that other underground structures or utilities may not be encountered.

1.19 Public and Private Utilities

- A. Utilities:
 - 1. CONTRACTOR must provide adequate protection for water, sewer, gas, telephone, TV cable, or any other public or private utilities encountered. CONTRACTOR will be held responsible for any damages to such utilities arising from CONTRACTOR'S operation.
 - 2. When it is apparent that construction operations may endanger the foundations of any utility conduit, or the support of any structure, 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, 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 or poles (electric or telephone) be moved to a new location, or moved and replaced after construction, CONTRACTOR shall arrange for the moving of such pole or poles, and the lines thereof, and shall pay any charges necessary to accomplish the relocation or replacement at no cost to OWNER, unless otherwise noted.
 - 5. Where it is the policy of any utility owner to make repairs to damaged conduit or other structures, 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. CONTRACTOR shall pay any charges related to repairs or damage done at no cost to OWNER.
- B. Existing Sewer Facilities:

1. Existing sewers or drains may be encountered along the line of work or within the Project site. In all such cases, CONTRACTOR shall perform the work in such a manner that sewer service will not be interrupted and shall make temporary provisions to maintain sewer service, which will be considered as incidental to the Work as bid.
 2. Unless otherwise indicated on the Contract Drawings, CONTRACTOR shall replace any disturbed sewer or drain, or relay same at a new grade and/or location to be established by OWNER or ENGINEER such that sufficient clearance for the sewer will be provided.
 3. 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 Contract 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.

1.20 Pumping, Bailing and Draining

- A. 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, CONTRACTOR shall provide, install, maintain, and operate suitable deep wells or well points, connecting manifolds and reliable pumping equipment to operate same to ensure proper construction of the Work. Alternate dewatering methods may be implemented if approved by OWNER and ENGINEER.
- 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, 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 Michigan Department of Environmental Quality (MDEQ) and local requirements for soil erosion and sedimentation control.
- D. CONTRACTOR shall receive no extra compensation for providing, maintaining or operating any dewatering or drainage facilities except where a separate bid item has been included in the proposal.

1.21 Sheeting, Shoring and Bracing

- A. Where necessary to construct the Work called for by the contract, to ensure the safety of CONTRACTOR's workers, or to protect other things of value, CONTRACTOR shall use and, if necessary, leave in place, sheeting, shoring, and bracing as is needed to carry out the work or to adequately ensure the stability of such work, or to ensure the safety of CONTRACTOR's workers and/or to protect adjoining things of value. CONTRACTOR will receive no extra compensation for sheeting, shoring, or bracing, whether removed or left in place except where a separate bid item has been included in the proposal.

1.22 Disposal of Excavated Material

- A. Excavated material shall remain on site unless otherwise specified; OWNER will designate an area where materials are to be disposed of. CONTRACTOR shall grade materials to blend in with the existing grades and seed final grade in accordance with the Contract Documents.

1.23 Disposal of Waste Materials

- A. Unless otherwise directed by OWNER, all waste materials and debris, including pavement, resulting from the construction work shall be removed from the premises at no extra cost to OWNER.
- B. CONTRACTOR shall, at all times, keep the premises free from accumulations of waste material or debris caused by CONTRACTOR's employees or their work, and shall remove same when necessary or required by OWNER.

1.24 Tunneling

- A. CONTRACTOR shall construct the Work in tunnel where shown on the Contract Drawings or required by permits, and at other locations may, at CONTRACTOR's 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 Contract Documents, permit requirements, or as otherwise noted at no extra cost to OWNER.

1.25 Inspection of Premises

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

1.26 Schedule of Operations

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

1.27 Ordinances and Codes

- A. The 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. Where the Work required by the Contract Drawings is above the standard required, it shall be done as shown or specified.

1.28 Traffic Control

- A. During construction CONTRACTOR shall control traffic in accordance with the current edition of the MMUTCD issued by MDOT.

1.29 Dust Control

- A. 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 OWNER.

1.30 Inconveniences

- A. 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 CONTRACTOR, OWNER, upon 4 hours' notice, reserves the right to perform the necessary work and to deduct the cost thereof from the money due or to become due to CONTRACTOR.

1.31 Photographs

- A. Photographs, as specified in Section 01 3300, Submittal Procedures, shall be required.

1.32 Audio/Video Route Survey

- A. An audio/video route survey, as specified in Section 01 3300, Submittal Procedures, shall be required for this Project.
- B. The audio/video route survey shall be in DVD format. CONTRACTOR shall submit a minimum of 3 DVD copies.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

End of Section

Section 01 2100 Allowances

Part 1 General

1.01 General

- A. CONTRACTOR shall include in his Bid the Allowances listed in the Bid Proposal. These Allowances shall cover work, manufactured equipment or services that will be provided either by CONTRACTOR or by others who may be selected by OWNER.
- B. Work performed under Allowances shall be subject to OWNER approval and under special terms described herein. CONTRACTOR shall coordinate and cause the work covered by these Allowances.
- C. It is understood that CONTRACTOR has included in the Contract Price all Allowances so named in the Contract Documents and shall cause the work so covered to be performed for such sums and by such persons or entities as may be acceptable to OWNER.

1.02 Requirements

- A. Allowances shall be administered in accordance with the provisions of the General Conditions of the Contract. CONTRACTOR shall be required to coordinate this work with the agency involved and pay all costs the agency may charge in connection with this work.
- B. Thereafter, if the actual price for this work is more or less than the allowance, the Contract Price shall be adjusted accordingly by Change Order. The adjustment in Contract Price shall be made on the basis of the actual invoice price without additional charge or markups for overhead, insurances, bonds, or any other incidental expenses.
- C. CONTRACTOR shall be responsible for all coordination with the agency involved and for the timely completion of the Work to fit his schedule. CONTRACTOR shall not be allowed any additional compensation for the failure of the agency involved to meet any schedule.

1.03 Definitions

- A. Lump Sum Allowance: A monetary sum that includes, as part of the Contract Price, the associated costs and requirements to complete the specified Allowance.
- B. Owner-Controlled Change Allowance: A monetary sum that is, as part of the Contract Price, the sole use of OWNER to cover unanticipated costs and will be used only under the direction of OWNER.

1.04 Submittals

- A. Submit invoices or delivery slips to indicate actual quantities of materials delivered to the Site for use in fulfillment of each Allowance.

1.05 Instructions

- A. At the earliest feasible date after Contract Award, CONTRACTOR shall advise ENGINEER of the date when the final selection and purchase of each product or system described by an Allowance must be completed in order to avoid delay in performance of the work.

- B. When requested by ENGINEER, CONTRACTOR shall obtain Bids for each Allowance for use in making final selections; include recommendations that are relevant to performance of the Work.
- C. CONTRACTOR shall purchase products and systems as selected by ENGINEER from the designated Supplier.
- D. Allowances shall be used only as directed for OWNER's purposes, and only by Change Orders which designate amounts to be charged to the Allowance.
- E. If the actual price for the specified Allowance is more or less than the stated Allowance, the Contract Price shall be adjusted accordingly by Change Order. The adjustment in Contract Price shall be made in accordance with the General Conditions.
- F. At Project closeout, any amounts remaining in Allowances will be credited to OWNER by Change Order.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

End of Section

Section 01 2200 Unit Prices

Part 1 General

1.01 Scope

- A. This Section describes the method of measurement and basis of payment for all items of Work included in the Contract and specified in the Proposal. CONTRACTOR shall provide labor, material, tools, equipment and services required to complete the Work specified herein and indicated on the Plans.
- B. OWNER WILL MAKE NO ALLOWANCES FOR ITEMS NOT INCLUDED IN THE PROPOSAL.

1.02 Items of the Proposal

Item 1

Mobilization will be paid for at the Contract Unit Price on a Lump Sum basis. Price paid shall be payment in full for labor, material, and equipment necessary for preparatory work and operations, including, but not limited to, those necessary for the movement of personnel, equipment, supplies, and incidentals to the project site; for the establishment of CONTRACTOR's, ENGINEER's, and OWNER's field offices, and other facilities necessary to undertake the work on the project; and for other work and operations which must be performed, or for expenses incurred, prior to beginning work on the various contract items on the project site. It shall also include preconstruction costs, including insurance and bonds, exclusive of bidding costs, which are necessary direct costs to the project and are of a general nature rather than directly attributable to other pay items under the contract. Payment for mobilization will be based upon the following schedule:

Partial Payment Schedule

Percentage of Original Contract Amount Earned	Percentage of Bid Price for Mobilization Allowed
5	50
10	75
25	100

Item 2

Bypass Pumping will be paid for at the Contract Unit Price on a Lump Sum basis. Price paid shall be payment in full for labor, material, and equipment necessary to set up, operate, and maintain bypass pumping as necessary to divert the flow of water or sewage around the section of pipe in which liner preparation and installation is being performed. This pay item shall include, but is not limited to, bulkheads and/or other isolation methods, pumping equipment capable of handling the anticipated flows, stand-by pumps, piping, valves, joints, fittings, thrust and restraint blocks, standby power source, pump operators available 24-hours a day, barricading, restoration, cleanup, and other related appurtenances necessary to complete the job, whether specifically mentioned or implied.

Item 3

Influent Structure Structural Rehabilitation will be paid for at the Contract Unit Price on a Lump Sum basis. Price paid shall be payment in full for labor, material, and equipment necessary for internal repair of concrete and reinforcing steel, including but not limited to demolition of select structural features including concrete trough and walls, weir plates, and manhole rungs; surface preparation and cleaning of concrete and existing reinforcing steel; application and curing of geopolymer coating; furnishing and installing the necessary blocks and concrete to create a bulkhead to separate Battery A Grit from Battery B Grit; furnishing, cutting, placing, and installation

of new reinforcing steel to the inside of the Influent Structure; furnishing and installing new slide gates, including framing, hardware, stem extensions, hangers and actuators, modification of existing aluminum covers to accommodate gate actuators; pipe rehabilitation of the 54-inch existing pipe between Influent Structure and Battery A grit, including surface preparation and cleaning of internal pipe walls and application and curing of geopolymer coating; demolition of the existing venturi meter and ancillary equipment in the 54-inch pipe to Battery A Grit, including cutting, removal, and disposal; furnishing and installing new 54-inch magnetic meter and ancillary equipment in the 54-inch pipe to Battery A Grit; barricading, restoration, cleanup, and other related appurtenances necessary to complete the job, whether specifically mentioned or implied in the Contract Documents.

Item 4

Influent Structure Brick Replacement will be paid for at the Contract Unit Price based on the actual quantity of brick replaced on the Influent Structure. Price paid shall be payment in full for all labor, material and equipment for performing this work, and all other items necessary to complete the job, whether specifically mentioned or not. Actual quantity to be agreed upon in the field during construction at a walk-through at the building with CONTRACTOR, OWNER and ENGINEER. Quantities listed in the bid proposal are to establish a base dollar amount in the Contract, which will be adjusted up or down based on actual quantities. The Work included and required by this item are described and shall be completed in accordance with Sections 04 0511 Mortar and Grout, and 04 2200 Unit Masonry System, and the notes on Sheets A1.0 and A2.0 of the Contract Drawings. This item includes the replacement of deteriorated/cracked brick at the denoted walls of the Influent Structure.

Item 5

Influent Structure Brick Repointing will be paid for at the Contract Unit Price based on the actual lineal footage quantity of brick joint repointing on the Influent Structure. Price paid shall be payment in full for all labor, material and equipment for performing this work, and all other items necessary to complete the job, whether specifically mentioned or not. Actual quantity to be agreed upon in the field during construction at a walk-through at the building with CONTRACTOR, OWNER and ENGINEER. Quantities listed in the bid proposal are to establish a base dollar amount in the Contract, which will be adjusted up or down based on actual quantities. The Work included and required by this item are described and shall be completed in accordance with Sections 04 0511 Mortar and Grout, and 04 2200 Unit Masonry System, and the notes on Sheets A1.0 and A2.0 of the Contract Drawings. This item includes the removal and installation of new mortar at deteriorated/cracked brick joints at the denoted walls of the Influent Structure, as well as barricading, restoration, cleanup, and other related appurtenances necessary to complete the job, whether specifically mentioned or implied in the Contract Documents.

Item 6

Battery A Grit Improvements & Grit Handling Building will be paid for at the Contract Unit Price on a Lump Sum basis. Price paid shall be payment in full for labor, material, and equipment necessary for demolition of the existing grit removal equipment for Battery A Grit, as designated in the Contract Drawings including but not limited to pumps, motors, conveyors, aeration units, piping, valves, headers, meters, supports, hangers; soil erosion control measures, clearing and grubbing, excavation, dewatering, disposal of unsuitable or excess materials, sheeting, shoring, bracing, subgrade preparation; new building, including but not limited to foundations, walls, doors, windows, roof, lighting, HVAC, sanitary sewer piping, potable/non-potable water piping, storm sewer piping, ladder, roof access; concrete housekeeping pads, bollards; grit classification equipment, including ancillary equipment and appurtenances for a Class 1, Division 1 area; barricading and protection of adjacent features, restoration, cleanup, and other related appurtenances necessary to complete the job, whether specifically mentioned or implied in the Contract Documents.

Item 7

SCADA Programming Allowance will cover costs throughout the course of the project related to SCADA programming. CONTRACTOR will obtain OWNER's written acceptance before providing equipment, materials, programming services or other Work under this allowance. Payments under this allowance will be made based on actual costs, excluding costs of general conditions, handling, unloading, storage, installation, etc., which will be considered to be included within the Contract Price. Payments within the limits of any allowance will exclude overhead and profit and bond and insurance premiums, since those costs will be considered to be included within the Contract Amount. CONTRACTOR shall submit appropriate documentation to validate the actual cost of the item(s). The amount of the allowance shall be adjusted accordingly by Change Order to recognize the allowable cost incurred by CONTRACTOR at direction of OWNER.

Item 8

Owner-Controlled Contingency Allowance will cover unanticipated costs throughout the course of the project. CONTRACTOR will obtain OWNER's written acceptance before providing equipment, materials or other Work under this allowance. Payments under this allowance will be made based on actual costs, excluding costs of general conditions, handling, unloading, storage, installation, etc., which will be considered to be included within the Contract Price. Payments within the limits of any allowance will exclude overhead and profit and bond and insurance premiums, since those costs will be considered to be included within the Contract Amount. CONTRACTOR shall submit appropriate documentation to validate the actual cost of the item(s). The amount of the allowance shall be adjusted accordingly by Change Order to recognize the allowable cost incurred by CONTRACTOR at direction of OWNER.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

End of Section

Section 01 2513 Substitution Procedures

Part 1 General

1.01 Section Includes

- A. Options for making product or process selections.
- B. Procedures for proposing equivalent construction products or processes, including preapproved, prequalified, and approved products or processes.

1.02 Definitions

- A. Product: Means materials, equipment, or systems incorporated into the Project. Product does not include machinery and equipment used for production, fabrication, conveying, and erection of the Work. Products may also include existing materials or components designated for reuse.
- B. Process: Any proprietary system or method for installing system components resulting in an integral, functioning part of the Work. For this Section, the word Product includes Processes.

1.03 Selection Options

- A. Preapproved Products: Construction products of certain manufacturers or suppliers designated in the Specifications as "preapproved." A list of preapproved products is maintained by OWNER. Preapproved products for this Project are designated as preapproved in the Specifications. Products of other manufacturers or suppliers will not be acceptable for this Project and will not be considered under the submittal process for approving alternate products.
- B. Prequalified Products: Construction products of certain manufacturers or suppliers designated in the Specifications as "prequalified." Prequalified products for this Project are designated as prequalified in the Specifications. Products of other manufacturers or suppliers will not be acceptable for this Project and will not be considered under the submittal process for approving alternate products.
- C. Approved Products: Construction products or processes of certain manufacturers or suppliers designated in the Specifications followed by the words "or approved equal." Approval of alternate products or processes not listed in the Specifications may be obtained through provisions for product options and substitutions in Section 00 7200, General Conditions, and by following the submittal procedures specified in Section 01 3300, Submittal Procedures. The procedure for approval of alternate products is not applicable to preapproved or prequalified products.
- D. Product Compatibility: To the maximum extent possible, provide products that are of the same type or function from a single manufacturer, make, or source. Where more than one choice is available as a CONTRACTOR's option, select a product which is compatible with other products already selected, specified, or in use by OWNER.

1.04 CONTRACTOR's Responsibility

- A. CONTRACTOR's responsibility related to product options and substitutions is defined in Section 00 7200, General Conditions.

- B. Complete the Substitution Request Form provided in Section 00 6325 and furnish information ENGINEER deems necessary to judge equivalency of the alternate product.
- C. Pay for laboratory testing, as well as any other review or examination costs, needed to establish the equivalency between products in order to obtain information upon which ENGINEER can base a decision.
- D. If ENGINEER determines that an alternate product is not equal to that named in the Specifications, CONTRACTOR shall furnish one of the specified products.

1.05 ENGINEER's Review

- A. Alternate products or processes may be used only if approved in writing by ENGINEER. ENGINEER's determination regarding acceptance of a proposed alternate product is final.
- B. Alternate products will be accepted if the product is judged by ENGINEER to be equivalent to the specified product or to offer substantial benefit to OWNER.
- C. OWNER retains the right to accept any product or process deemed advantageous to OWNER, and similarly, to reject any product or process deemed not beneficial to OWNER.

1.06 Substitution Procedure

- A. Collect and assemble technical information applicable to the proposed product to aid in determining equivalency as related to the approved product specified.
- B. Submit a written request for a construction product to be considered as an alternate product.
- C. Submit the product information after the effective date of the Agreement and within the time period allowed for substitution submittals given in Section 00 7200, General Conditions. After the submittal period has expired, requests for alternate products will be considered only when a specified product becomes unavailable because of conditions beyond CONTRACTOR's control.
- D. Submit six (6) copies of each request for alternate product approval. Include the following information:
 - 1. Complete data substantiating compliance of proposed substitution with Contract Documents.
 - 2. For products:
 - a. Product identification, including manufacturer's name and address.
 - b. Manufacturer's literature with product description, performance and test data, and reference standards.
 - c. Samples, as applicable.
 - d. Name and address of similar projects on which product was used and date of installation. Include the name of OWNER, ENGINEER, and CONTRACTOR.

3. For construction methods:
 - a. Detailed description of proposed method.
 - b. Drawings illustrating methods.
 4. Itemized comparison of proposed substitution with product or method specified.
 5. Data relating to changes in construction schedule.
 6. Relation to separate contracts, if any.
 7. Accurate cost data on proposed substitution in comparison with product or method specified.
 8. Other information requested by ENGINEER.
- E. Approved alternate products will be subject to the same review process as the specified product would have been for shop drawings, product data, and samples.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

End of Section

Section 01 3119 Project Meetings

Part 1 General

1.01 Preconstruction Meeting

- A. Prior to the delivery of materials or the start of any construction, CONTRACTOR shall request a Preconstruction Meeting from ENGINEER. A minimum three (3) working days' notification to meeting participants shall be required.
- B. Schedule:
 - 1. ENGINEER will establish the meeting place, time and date, distribute agenda, notify participants, and administer the meeting. CONTRACTOR shall notify major Subcontractors.
- C. Attendance:
 - 1. OWNER
 - 2. ENGINEER
 - 3. CONTRACTOR
 - 4. Major Subcontractors
 - 5. Utility Companies
 - 6. Safety Representatives
 - 7. Governmental Agencies
- D. Agenda:
 - 1. Distribution by CONTRACTOR and discussion, review and acceptance of:
 - a. List of names and telephone numbers for superintendent, foreman and other key personnel.
 - b. List of major Subcontractors and Suppliers.
 - c. Projected construction preliminary progress schedules.
 - d. Preliminary schedule of Shop Drawings and Sample submittals.
 - e. Estimated monthly payment schedule and schedule of values
 - 2. Critical Work sequencing.
 - 3. Major equipment deliveries and priorities.
 - 4. Project coordination.
 - 5. Responsibilities of OWNER, ENGINEER, CONTRACTOR and other agencies.
 - 6. Procedures and processing of:
 - a. Field decisions.
 - b. Proposal requests.
 - c. Submittals.
 - d. Change Orders.
 - e. Applications for Payment.

7. Adequacy of distribution of Contract Documents.
8. Procedures for maintaining Record Documents.
9. Use of premises.
10. Construction facilities, controls and construction aids.
11. Temporary utilities.
12. Safety and first aid procedures.
13. Security procedures.
14. Housekeeping procedures.
15. Testing

E. Minutes:

1. ENGINEER will prepare and distribute copies to participants within seven (7) days of meeting. Participants shall report corrections and comments within ten (10) days of receipt of minutes.

1.02 Progress Meetings

A. Periodic Progress Meetings will be held as required by the progress of the Work.

B. Schedule:

1. ENGINEER will establish the meeting place, time and date, distribute agenda, notify participants and administer the meeting. CONTRACTOR shall notify major Subcontractors.

C. Attendance:

1. OWNER
2. ENGINEER
3. CONTRACTOR
4. Subcontractor as appropriate to the agenda.
5. Suppliers as appropriate to the agenda.
6. Others

D. Agenda:

1. Review minutes of previous meeting.
2. Review of work progress since previous meeting.
3. Review field observations, problems, conflicts.
4. Review problems which impede Construction Schedules.
5. Review of off-site fabrication, delivery schedules.
6. Review corrective measures and procedures to regain projected schedule.
7. Review revisions to Construction Schedules.
8. Review plan progress, schedule, during succeeding Work period.
9. Review coordination of schedules.
10. Review submittal schedules; expedite as required.
11. Review maintenance of quality standards.
12. Review proposed changes for:
 - a. Effect on Construction Schedule and on completion date.
 - b. Effect on other Contracts of the Project.
13. Other business.

- E. Minutes:
 - 1. ENGINEER will prepare and distribute copies to participants and OWNER within seven (7) days of meeting for review at the next meeting.

1.03 Preinstallation Meeting

- A. When required in individual specification sections, CONTRACTOR convene a preinstallation meeting at the Site prior to commencing work of the section.
 - 1. Notify OWNER and ENGINEER four (4) days in advance of meeting date.
- B. CONTRACTOR shall require the attendance of parties directly affecting, or affected by, Work of the specific section.
- C. Prepare agenda and preside at meeting:
 - 1. Review conditions of installation, preparation and installation procedures.
 - 2. Review coordination with related work.
- D. CONTRACTOR shall record and distribute copies of meeting minutes within two (2) 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 01 3300 Submittal Procedures

Part 1 General

1.01 General Requirements

- A. CONTRACTOR shall submit Shop Drawings, product data, and Samples, as required by the individual Specification Sections, to ENGINEER for review in accordance with the provisions of General Conditions.

1.02 Schedule for Submission

- A. Prior to submitting any shop drawings, product data, portfolios, samples, etc. CONTRACTOR shall prepare a summary listing all items in the project which will be submitted for review by ENGINEER.
- B. The summary shall be submitted within twenty (20) calendar days after receipt of Notice to Proceed and shall be updated once per month thereafter.
- C. The summary shall include the proposed dates for submittal for each item for control purposes. The summary shall be prepared in coordination with the Project Schedule, allowing adequate time for review by ENGINEER and possible resubmittal by CONTRACTOR.
- D. The summary and schedule for submittals shall not relieve CONTRACTOR of his obligation to comply with specification requirements for items not listed on the Project Schedule.
- E. Nothing herein shall be construed as allowing additional time for completion of the project in the event resubmittal is required for shop drawings or the other items to be submitted.

1.03 Submission Requirements

- A. CONTRACTOR shall submit an entire package of Shop Drawings and product data information for major items of Work so that ENGINEER can review the package as a unit. CONTRACTOR shall transmit each submittal with an ENGINEER-approved transmittal form.
- B. Schedule submittals to expedite the Project and deliver to ENGINEER in a manner to allow sufficient time for review and processing by ENGINEER so as to not cause delays in the Work. CONTRACTOR shall coordinate submission of related items.
- C. Drawings, information and documentation shall be prepared and submitted with all words in the English language and dimensions in American units; no foreign language or metric units will be permitted.
- D. Identify variations from Contract Documents and Products and system limitations which may be detrimental to successful performance of the completed Work.
- E. Distribute copies of reviewed submittals to all concerned and related parties. Instruct parties to promptly report any inability to comply with provisions.
- F. ENGINEER reserves the right to refuse to check or review any submittal of a Subcontractor, Supplier or manufacturer which is not presented in compliance with the foregoing requirements.

- G. Each submittal shall:
1. Be sequentially number the transmittal form. Re-submittals shall have original number and a sequential alphabetic suffix.
 2. Identify Project, CONTRACTOR, Subcontractor and supplier; pertinent drawing and detail number, and specification section number, as appropriate.
 3. Have CONTRACTOR's stamp that has been initialed or signed, certifying CONTRACTOR's review and approval of submittal per the General Conditions, verification of products, field measurements, field construction criteria, and coordination of the information within the submittal with requirements of the Work and of Contract Documents.
- H. Electronic Submittals:
1. Electronic submittals shall follow the procedures outlined above.
 2. Electronic submittal procedures are only applicable to Shop Drawings and product data submittals.
 3. Electronic submittals shall be made in a standard format ENGINEER has agreed in advance to accept, JPEG, TIF, DGN, DXF, DWG, or PDF.
 4. Reviewed submittals shall be returned in JPEG, TIF, or PDF electronic format for CONTRACTOR's printing and distribution.

1.04 Submittal Review

- A. Subcontractors, Suppliers and manufacturers' submittals shall first be sent directly to CONTRACTOR, who shall keep a record of the submittal numbers and the dates of receipt. CONTRACTOR shall check thoroughly the submittal in regard to measurements, sizes of members, materials, and other details to assure CONTRACTOR that they conform to the intent of the drawings and the specification, and shall promptly return to the Subcontractors, Suppliers and/or manufacturers for correction such submittals as are found inaccurate or otherwise in error.
- B. ENGINEER will review the submittal within a reasonable time after receipt thereof and will return one (1) copy (unless otherwise specified), endeavoring to indicate, by notation thereon or written instructions, any correction which may be necessary to meet the Contract requirements.
1. CONTRACTOR shall then review such notations and/or instructions and if CONTRACTOR concurs therein, shall make or have made such required corrections, and shall, when so noted on submittals or requested by ENGINEER, resubmit corrected submittals to ENGINEER as soon as possible, for final review.
 2. Such further review by ENGINEER will be limited to the corrections only, and CONTRACTOR, by such re-submission shall be held to have represented that such submittals contain no other alterations, additions or deletions, unless CONTRACTOR (in writing) directs ENGINEER 's specific attention to same.
 3. Should CONTRACTOR question, or dissent from, such notations and/or instructions, CONTRACTOR shall so inform ENGINEER and request further clarification before resubmitting submittals.

- C. Review of submittals by ENGINEER is for coordination and assistance, and ENGINEER does not thereby assume responsibility for errors or omissions. Such errors or omissions must be made good by CONTRACTOR, irrespective of the receipt, review of the submittals by ENGINEER, and even though the Work is done in accordance with such submittals.

1.05 Resubmission Requirements

- A. CONTRACTOR shall make all corrections or changes in the submittals required by ENGINEER and resubmit. CONTRACTOR shall indicate any changes which have been made other than those requested by ENGINEER.

1.06 Progress Schedules

- A. CONTRACTOR shall submit a copy of each Progress Schedule indicating the starting and completion dates of the various stages of the Work and estimated payments during the next 3 months to ENGINEER.
 - 1. Proposed Progress Schedules shall be submitted to ENGINEER prior to the preconstruction meeting.
 - 2. CONTRACTOR shall distribute copies of the Progress Schedules during the preconstruction meeting for discussion.
 - 3. Progress Schedules shall be updated by CONTRACTOR and submitted to ENGINEER, as a part of applications for progress payments, through completion of the Work. Failure to update progress schedule may be the basis for rejection of applications for progress payments.

1.07 Shop Drawing Schedule

- A. CONTRACTOR shall submit a copy of each Shop Drawing Schedules indicating the individual items and submission dates to ENGINEER.
 - 1. A preliminary Schedule in accordance with the requirements in the General Conditions shall be submitted by CONTRACTOR prior to the preconstruction meeting.
 - 2. Copies of this preliminary Schedule shall be made available by CONTRACTOR during the preconstruction meeting.
 - 3. A final Schedule shall be submitted by CONTRACTOR at least ten (10) days prior to submitting the first Application for a Payment.

1.08 Schedule of Values

- A. CONTRACTOR, if applicable, shall a copy of the Schedule of Value of the Work to ENGINEER.
 - 1. A preliminary Schedule of Values shall be submitted by CONTRACTOR prior to the preconstruction meeting.
 - 2. A final Schedule of Values, prepared in accordance with the General Conditions and presented in sufficient detail to serve as the basis for payments during construction, shall be submitted to ENGINEER for approval at least ten (10) days prior to submitting the first Application for Payment.

1.09 Staking Schedule

- A. CONTRACTOR shall submit a copy of the Staking Schedule, in accordance with the "Construction Layout" specification section prior to the Start of Construction.
 - 1. The Staking Schedule should be updated as outlined in the specifications and submitted by CONTRACTOR to ENGINEER through completion of the Work.

1.10 Applications for Payment

- A. CONTRACTOR shall submit Applications for Payment to ENGINEER in accordance with the provisions of Article 14 of the General Conditions.
- B. Applications for Payment shall be made on forms provided by or approved by ENGINEER.
 - 1. Sample CONTRACTOR's Application/Declaration, Payment Schedule and ENGINEER's Certificate forms for this purpose are included in the Contract Documents.
- C. Copies of these forms, with Project specific information completed by ENGINEER, will be given to CONTRACTOR at the preconstruction meeting or, if applicable, after approval of the final Schedule of Values.
- D. CONTRACTOR shall submit a completed Payment Schedule with an executed Contractor's Application for Payment and Contractor's Declaration to ENGINEER not more often than once per month.
- E. ENGINEER will certify payments with the use of Engineer's Certificate for Payment.

1.11 Shop Drawings

- A. Shop Drawings shall be presented in a clear and thorough manner. Details shall be identified by reference to Plan Sheet Number and Detail, and Specification Section Number and Page Number.

1.12 Product Data

- A. Product data shall be presented in a clear and thorough manner identified the same as the Shop Drawings. Included with the information shall be performance characteristics and capacities depicting dimensions and clearances required.
- B. Manufacturer's standard schematic drawings and diagrams shall be modified to delete information which is not applicable to the Work. Manufacturer's standard information shall be supplemented to provide information specifically applicable to the Work.

1.13 Samples

- A. Samples shall be of sufficient size and quantity to clearly illustrate functional characteristics of the product with integrally related parts and attachment devices depicting full range of color, texture and pattern.

1.14 Specification Section Requirements

- A. Miscellaneous schedules, field reports, test reports, affidavits, certificates, permits, agreements and other items identified in the Specification Sections, or as requested by ENGINEER shall be submitted to ENGINEER.

- B. As a minimum, these submittals should be identified with the Project title, date of submission, and Specification section reference.

1.15 Manufacturer Installation Instructions

- A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation and start-up to ENGINEER in quantities specified for Product Data.
- B. Identify conflicts between manufacturer's instructions and Contract Documents.

1.16 Manufacturer Certificates

- A. When specified in individual sections, submit certification by manufacturer to ENGINEER in quantities specified for Product Data.
- B. Indicate material or Product meets or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
- C. Certificates may be recent or previous test results on material or Product but must be acceptable to ENGINEER.

1.17 Manufacturer's Operation and Maintenance Data

- A. CONTRACTOR shall furnish four (4) copies of all operation and maintenance data required per the various Specification Sections.
 - 1. Prior to 50% completion of the Project, CONTRACTOR shall have submitted one (1) acceptable copy to ENGINEER for review.
- B. Operation and maintenance data shall be bound in a suitable number of 3-inch or 4-inch, 3-ring hard cover binders. Permanently imprinted on the cover shall be the words "Manufacturer's Operation and Maintenance Data", Project title, location of the Project, and the date. A table of contents shall be provided in the front of each binder to list the various sections in the manual.
- C. The information to be provided in each section of the manual, for each piece of equipment and project component shall include, but not be limited to, detailed equipment drawings; sections cut through all of the major equipment and subassemblies; installation and operational procedures; complete wiring and piping schematics; lubrication materials and procedures; maintenance procedures; and parts lists complete enough to permit identification of parts by nomenclature, manufacturer's part number and use.
- D. At the front of each section a maintenance schedule shall be provided for each piece of equipment in the section.
 - 1. The schedule shall display the daily, weekly, monthly, semi-annual, annual or fraction thereof, lubrication and preventative maintenance required in order to meet warranty conditions and the manufacturer's recommendations for optimum performance and life of the unit.
 - 2. A common schedule format is to be developed and used for all of the sections. Photocopies or reproductions of the manufacturer's literature will not be accepted.

1.18 Photographs

- A. When required in the Summary of Work, Section 01 1100, CONTRACTOR shall furnish ENGINEER a minimum of four (4) color digital photographs each month during construction of the Project. All photographs shall be taken at such times and of such views as ENGINEER directs.
- B. The following information shall be placed on the back of the photos: job name, contract number, description of view and date of photograph. CONTRACTOR shall submit photographs monthly along with the Application for progress Payment as described in Article 14 of the General Conditions.

1.19 Audio/Video Route Survey

- A. When required in the Summary of Work, Section 01 1100, or the Proposal, CONTRACTOR shall furnish ENGINEER with an "Audio/Video Route Survey" record of the existing conditions prior to the start of construction. CONTRACTOR must enlist the services of a firm having a minimum of one (1) year experience in audio/video recording of construction projects.
- B. Prior to beginning the audio/video recording, CONTRACTOR shall review with ENGINEER the Project requirements to ensure that the audio/video is adequate for its intended purpose. OWNER shall have the authority to designate areas for which coverage may be added or omitted. The audio/video recording shall be done prior to placement of materials or equipment on the construction area and furnished one (1) week prior to the preconstruction meeting.
- C. Format:
 - 1. Audio/Video route survey shall be submitted in the format(s) as specified in Section 01 1100, Summary of Work.
 - a. Audio/video route survey submission shall be on media meeting the following specifications:
 - (1) Media: DVD or USB
 - (2) Format: Video
 - (3) Video Encoding: Highest available bit rate (6-9 Megabit), 60 fields per second interlaced video
 - (4) Audio Encoding: Uncompressed stereo wave or stereo Dolby Digital (256 kilobit or better)
 - (5) Aspect Ratio: 4x3 (720x480 pixels)
 - (6) No Macrovision or other copy protection encoding. No region code or region code 1.
- D. Complete coverage shall include all surface features located within the public right-of-way, easement areas and adjacent private properties up to building line when such properties lie within the zone of influence of construction and will be supported by appropriate audio description made simultaneously with video coverage.

1. Such coverage shall include, but not be limited to, all existing driveways, sidewalks, curbs, ditches, roadways, landscaping, trees, culvert, headwalls, retaining walls, and buildings located within such zone of influence.
 2. Video coverage shall be clear enough to identify cracks, depressions, holes and other defects in existing surfaces.
- E. Houses and buildings shall be identified visually by house number, when visible, in such a manner that structures of the proposed system can be located by reference. In all instances, however, location shall be identified by audio or visual means at intervals not-to-exceed 100 linear feet (30 m) in the general direction of travel.
- F. When conventional wheeled vehicles are used, the distance from the camera lens to the ground shall be not less than 12 feet (3.5 m) to ensure proper perspective. The rate of speed in the general direction of travel of the conveyance used during recording shall not exceed 30 feet/minute (10 m/min). Panning rates and zoom-in, zoom-out rates shall be controlled sufficiently such that stop action during play-back will produce clarity of detail of the object viewed.
- G. Video recordings must, by electronic means, display continuously and simultaneously generated transparent digital information to include the date and time of recording, as well as the corresponding engineering stationing numbers as shown on the Plans.
1. The date information will contain the month, day, and year. For example, mm/dd/yy, and be placed directly below the time information.
 2. The time information shall consist of hours, minutes, and seconds, separated by colons. For example, hh:mm:ss.
- H. This transparent information will appear on the extreme upper left hand third of the screen. The engineering stationing numbers must be continuous, accurate and correspond to the Project stationing and must include the standard engineering symbols. For example, Station 14 + 84. This transparent information must appear in the lower half of the viewing screen.
- I. Recording shall be done during times of good visibility. No recording shall be done during periods of visible precipitation, or when more than ten (10) percent of the ground area is covered with snow or standing water, unless otherwise authorized by OWNER.
- J. In some instances, audio/video coverage may not be suitable for recording necessary details. In such instances, OWNER may specify still photographs to provide coverage. One (1) color print of each such photograph shall be provided in 8" x 10" size. A suitable description of location of photograph shall be attached permanently to each print.
- K. Any portion of the Audio/Video Route Survey of insufficient quality as determined by ENGINEER shall be redone by CONTRACTOR at no additional cost to OWNER.
- L. DVD disks or USBs be properly identified as to Project, location, time, and date in a manner acceptable to OWNER.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

End of Section

Section 01 4500 Quality Control

Part 1 General

1.01 General Requirements

- A. Sampling of materials will be made by ENGINEER in accordance with the methods designated by the Specifications. CONTRACTOR shall furnish such facilities as ENGINEER may require for collecting, storing, and forwarding samples to the Laboratory. CONTRACTOR in all cases shall furnish the required samples to OWNER without charge.

1.02 Control of Installation

- A. Monitor quality control over Suppliers, manufacturers, products, materials, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, request clarification from ENGINEER before proceeding.
- D. 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.
- E. Work shall be performed by persons qualified to produce workmanship of specified quality.
- F. Secure products and materials in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.03 Tests of Materials

- A. Materials in the Work shall meet the requirements of the Contract Documents.
- B. Tests of materials will be made as specified herein. CONTRACTOR will appoint, employ, and pay for specified services of an independent firm to perform inspecting and testing, as required for concrete testing, soils compaction density and gradation testing, and asphalt density testing.
 - 1. The independent firm will perform inspections, tests, and other services specified in individual specification sections and as required by ENGINEER or OWNER.
 - 2. Inspecting, testing, and source quality control may occur on or off the project site. Perform off site inspecting or testing as required by ENGINEER or OWNER.
- C. Reports will be submitted by the independent firm to ENGINEER, in duplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.
- D. ENGINEER shall have access to materials intended for use in the Work as well as to the plants where such materials are produced. Plant inspection may be made if the quantities are sufficient to warrant such inspection and if it is to the best interest of OWNER. In any case materials may be either inspected or tested when received on the Project.

- E. Materials shall not be used until approval has been received from ENGINEER. Approval of materials at the producing plant does not constitute a waiver of ENGINEER's right for re-examination at the Project site.
- F. Standards for testing materials, unless otherwise specified, shall be as established by the American Society for Testing and Materials (ASTM). Tests of materials will be made in accordance with the methods described or designated in the Specifications.
- G. Sampling and testing of materials not specifically mentioned shall be done by generally accepted methods, unless otherwise specified by ENGINEER.
- H. Notify ENGINEER and independent firm 48 hours prior to expected time for operations requiring services.
- I. Testing or inspecting does not relieve CONTRACTOR of performing Work to Contract requirements.
- J. Retesting required because of non-conformance to specified requirements shall be performed by the same independent firm on instructions by ENGINEER. Payment for retesting will be charged to CONTRACTOR by deducting inspecting or testing charges from the Contract Price.

1.04 Certification of Materials

- A. At the request of ENGINEER, CONTRACTOR shall provide ENGINEER with certification that the various materials to be used conform to the standards referred to in the Contract Documents.

1.05 Source Quality Control

- A. Testing identified in the Specifications as Source Quality Control, which is required to establish quality of materials, equipment or fabricated items, shall be paid for by CONTRACTOR.

1.06 Inspector Days

- A. Resident Project Representative(s) will be assigned to the Project by ENGINEER, as necessary (in the opinion of ENGINEER) to adequately monitor CONTRACTOR's work.
 - 1. When multiple CONTRACTOR crews are working on the Project, multiple Resident Project Representatives may be assigned to the Project.
- B. If the quantity of Work under the Contract is changed, the number of "Inspector Days" shall be increased or decreased as determined by Article 10 or 11 of the General Conditions. This revision in the number of Inspector Days shall be agreed upon at the time the Contract quantities are revised.
- C. CONTRACTOR shall give ENGINEER at least 48 hours notice, exclusive of Saturdays, Sundays or holidays, when the Project requires an increase or decrease in the number of Resident Project Representatives.
 - 1. Failure to observe this requirement will either necessitate the charging of 4 hours show-up time if the Resident Project Representative appears on the Project, or the halting of all additional operations until a Resident Project Representative is available.

- D. Unless the Resident Project Representative is notified in advance, Inspector days will be charged when a Resident Project Representative appears on a project and CONTRACTOR decides not to work.
- E. A separate Inspector Day or a partial Inspector Day shall be charged for each and every Resident Project Representative working on a project for monitoring purposes.

1.07 Mock Ups

- A. Tests will be performed under provisions identified in this Section and identified in the respective specification sections.
- 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 ups have been accepted by ENGINEER and is specified in specification section(s) to be removed, CONTRACTOR shall remove mock up and clear area when directed to do so.

1.08 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 surfaces and installation, quality of workmanship, startup 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 (Not Used)

End of Section

Section 01 5000

Temporary Facilities and Controls

Part 1 General

1.01 Site Access and Parking

- A. CONTRACTOR shall locate roads, drives, walks and parking facilities to provide uninterrupted access to construction offices, mobilization, Work, storage areas, and other areas required for execution of the Contract. Access drives and parking areas shall be hard surfaced unless otherwise approved by ENGINEER.
- B. CONTRACTOR shall maintain driveways a minimum of 15 feet (5 m) wide between and around combustible materials in storage and mobilization areas.
- C. CONTRACTOR shall maintain traffic areas as free as possible of excavated materials, construction equipment, products, snow, ice, and debris.
- D. CONTRACTOR shall not utilize existing parking facilities for construction personnel or for CONTRACTOR's vehicles or equipment, unless written permission from owner of parking facility is obtained.

1.02 Trucking Route and Public Road Maintenance

- A. Prior to the start of construction, CONTRACTOR shall submit for review a schedule and list indicating the streets and roads within the municipality that his equipment will use off the Project site.
- B. CONTRACTOR shall comply with all safety requirements, weight restrictions and speed limits.
- C. Gravel and dirt roads or streets used shall be maintained by grading, placing dust palliatives and maintenance gravel in sufficient quantities to eliminate dust and maintain traffic.
- D. Paved streets shall be maintained in a reasonable state of cleanliness and CONTRACTOR shall remove accumulations of debris, dirt or mud caused by his operations. Removal shall be done in such a manner as to prevent the release of dust. This shall be done at least every day at the close of each day's operation or additionally when requested by ENGINEER.
- E. Roads or streets damaged by CONTRACTOR's operations, shall be repaired or removed and replaced to satisfactions of the agency having jurisdiction at no additional cost to the Project.
- F. In order to ensure adequate street maintenance and restoration as outlined above, CONTRACTOR may be required to deposit with the Agency having jurisdiction a cash Road Protection Bond.
 - 1. This Bond, if required, will be held in escrow until final release is given by the Agency having jurisdiction. In the event CONTRACTOR fails or neglects to maintain or restore the streets to the satisfaction of the Agency having jurisdiction, the Agency having jurisdiction shall have the required maintenance or restoration work done and the cost incurred shall be deducted from the Road Protection Bond.

2. At the completion of the Project, the Agency having jurisdiction shall return the Road Protection Bond less any monies expended by the Agency having jurisdiction and shall render to CONTRACTOR an accounting of all monies so expended.
- G. CONTRACTOR shall not store any equipment, supplies, construction material or excess excavated material on any roads or streets unless otherwise approved by ENGINEER.

1.03 Emergency Access

- A. CONTRACTOR shall provide emergency access to property in the vicinity of the construction for police vehicles, fire equipment, ambulances or other emergency vehicles to protect life, health and property. Any areas damaged by emergency vehicles shall be restored by CONTRACTOR at no additional cost to OWNER.

1.04 Private or Public Roads, Sidewalks, and Parking Areas

- A. Where public roads, driveways, parking areas and sidewalks are encountered throughout the community, CONTRACTOR shall maintain those portions affected by the construction operations in a passable condition until such time as final restoration of these improvements can be made as specified.
 1. If, in the opinion of ENGINEER, the public safety is in danger or the necessity exists for maintaining traffic, ENGINEER may direct that backfilling be completed immediately.
 2. In the event that the necessary backfill material and equipment are not available when direction is given for immediate backfill, the trench shall be backfilled with native material to provide for the necessary maintenance of traffic and safety; however, the native material shall be removed within 48 hours and the trench properly backfilled as specified.
- B. Where private roads are encountered throughout the community, CONTRACTOR shall maintain those portions affected by its construction operations in a passable condition. These roads shall be maintained by the use of 21A road maintenance gravel, stone or slag.
 1. In the event the original subbase has been destroyed, CONTRACTOR shall furnish and install 1-inch to 2-inch (25 to 50 mm) aggregate to stabilize the existing subbase.
 2. Upon completion of the construction activities, CONTRACTOR shall shape and regrade these roads leaving them in a condition as good as or better than original, and adequate for normal travel.

1.05 Work Within Railroad Company Right-of-Way

- A. CONTRACTOR shall be responsible for complying with the requirements of the Railroad Company for Work of the Project and/or temporary crossings for trucking routes.
- B. Unless otherwise provided by an item of these Specifications, CONTRACTOR shall bear costs and expenses incidental thereto, including, but not limited to, protection, flagmen, construction engineering inspection by the railroad, and incidental work such as drainage facilities and removal, alteration and replacement of railroad fences.

1.06 Road Closing

- A. No street, road or section thereof shall be closed to through traffic unless otherwise provided for on the Plans, Specifications, or authorized by the agency with jurisdiction over the roads. Prior to closing a street, road, or section thereof, CONTRACTOR shall provide ENGINEER with a copy of a detour plan approved by the agency having jurisdiction over the roads.
- B. In the event roads or streets are to be closed, CONTRACTOR shall notify the local fire department, police department, local road authority, ambulance and emergency services, Department of Public Works, public transit authority and public school system daily as to what streets will be partly blocked or closed, the length of time the streets will be blocked or closed and when the streets will be reopened to traffic. CONTRACTOR shall designate one responsible employee to carry out the requirements of this condition.
- C. During the time that the road is closed, CONTRACTOR shall make provision for trash, leaf, and rubbish pickup.

1.07 Maintaining Traffic

- A. CONTRACTOR shall provide access for local traffic to property along the Project by means of temporary roads, drives, culverts or other means approved by ENGINEER. CONTRACTOR shall grade, add surfacing materials, and dust palliatives to such temporary roads and drives as necessary for the proper maintenance of traffic.
- B. Where the shoulder is used to maintain traffic, the shoulder shall be graded, surfaced, treated for dust, constructed, or reconstructed, as specified herein or as shown on the Plans.
 - 1. If the construction work is suspended due to weather conditions, winter shut down or for any other reason, sufficient labor, materials and equipment shall be ready for immediate use at all times for the proper maintenance of traffic.
 - 2. Surfacing materials and dust palliatives shall be applied at such times and locations and in such amounts as necessary to safely maintain traffic and as determined by ENGINEER.
- C. Where shoulders are low, high, soft or rough, adequate provisions shall be taken to inform and protect the traveling public by means such as construction warning signs, barricades, lighted devices, etc. Such shoulder hazards shall be eliminated as soon as practicable.
- D. CONTRACTOR shall furnish, erect and maintain all signs, barricades, lights, and traffic regulators, in accordance with the requirements of the current "Michigan Manual of Uniform Traffic Control Devices." Furnish flagmen and watchmen as are necessary to maintain and safeguard traffic along the entire Project.
 - 1. Failure to comply with these requirements may be cause for the OWNER to issue a stop Work Order, which shall remain in effect until all necessary devices are in place and operational.
 - 2. The issuance of a stop Work Order shall not be reason for granting additional compensation or an extension to the Contract Time.
 - 3. Furnishing, installing, and maintaining traffic control devices shall be incidental to the Project unless otherwise provided for in the Proposal.

1.08 Existing Signs

- A. No stop sign, traffic control or warning device or sign shall be taken down until the agency having jurisdiction over the roads has been notified and arrangements for the immediate reinstallation has been made.
- B. CONTRACTOR shall provide temporary signs, traffic control devices, warning devices, or watchmen continuously from the time the item is removed until it is reinstalled.
- C. Signs removed shall be replaced with signs meeting requirements of the agency having jurisdiction over the roads.

1.09 Temporary Electricity and Lighting

- A. CONTRACTOR shall be responsible for and pay all costs for the installation and removal of circuit and branch wiring, with area distribution boxes located so that power and lighting is available throughout the construction by the use of construction-type power cords and shall pay all costs of electrical power used.
- B. Electrical wiring and distribution shall conform to the National Electrical Code as adopted by the State of Michigan.

1.10 Telephone

- A. CONTRACTOR is required by MIOSHA regulations to provide telephone service for contacting emergency services. Such emergency telephone service shall also be available for the use of OWNER and ENGINEER whether or not a field office is required for the Project. Emergency phone numbers are required to be posted per MIOSHA regulations.
- B. CONTRACTOR shall pay all costs for installation, maintenance and removal, and service charges for local calls to provide service for his construction site office as well as for ENGINEER's field office. Toll charges for calls relating to Project business shall be at CONTRACTOR'S expense.

1.11 Use of Water

- A. CONTRACTOR shall acquire any and all permits, post any bonds and pay all fees required by the local agency having jurisdiction prior to using any hydrant or any other source of water. CONTRACTOR shall reimburse the local community for water consumed during course of the Project at the current rate as set by the agency having jurisdiction.

1.12 Sanitary Provisions

- A. CONTRACTOR shall be responsible for installation, maintenance and removal of temporary sanitary facilities per MIOSHA regulations for use of construction personnel including OWNER and ENGINEER. All rules and regulations of the State and local health officials shall be observed, with precautions taken to avoid creating unsanitary conditions.

1.13 Potable Water

- A. CONTRACTOR shall furnish a supply of potable water per MIOSHA requirements, available for use of construction personnel including OWNER and ENGINEER.

1.14 Medical Services and First Aid

- A. CONTRACTOR shall furnish first aid supplies and a person trained in first aid with a valid first aid certificate, per MIOSHA requirements, available for use of construction personnel including OWNER and ENGINEER. CONTRACTOR shall also furnish a communication system for contacting emergency services. Telephone numbers of the physician, hospital, or emergency services shall be conspicuously posted at the job site.

1.15 Postal Service

- A. Several or all residents of this Project area may receive their mail at roadside mailboxes. Since the postal service will not deliver mail to a resident without a mailbox or a mailbox that is not in its proper position, CONTRACTOR shall relocate, replace and repair all mailboxes and posts in a condition and height acceptable to the post office within 24 hours of the removal.
- B. If required, CONTRACTOR shall furnish new posts for the mailboxes if the existing posts are broken or rotted to the extent that they cannot be reused.
- C. Mailbox damaged by CONTRACTOR while carrying out his operations or by anyone else while the box is down due to CONTRACTOR's operation, shall be replaced by CONTRACTOR with a new mailbox meeting the postal officials' specifications and the resident's name and address neatly lettered with paint or other acceptable means to the satisfaction of the resident and postal authorities. Cost for relocating mailboxes shall be incidental to the Project unless otherwise specified in the Proposal.

1.16 Newspaper Delivery

- A. Residents of this Project area may receive their newspapers at roadside tubes. Since the resident arranges for newspaper delivery, CONTRACTOR shall notify the resident 24 hours prior to removal of any newspaper tube. Newspaper tubes damaged by CONTRACTOR while carrying out his operations or by anyone else while the tube is down due to CONTRACTOR's operation, shall be replaced as agreed between CONTRACTOR and the newspaper who owns the damaged tube. Cost shall be incidental to the Project.

1.17 Bus Stops and Shelters

- A. Prior to the start of any construction, CONTRACTOR shall notify the transit authority that has any bus stops within the area of the Work. Removal, relocation and/or replacement of signs and/or benches shall be the responsibility of CONTRACTOR in accordance with any requirements of the transit authority. Cost shall be incidental to the Project.

1.18 Engineer's Field Office

- A. When called for in the Summary of Work, Section 01 1100, CONTRACTOR shall furnish and maintain, for the exclusive use of ENGINEER, an approved weatherproof building as a field office. The building shall be located as directed by ENGINEER, in full view of the Work and with at least one (1) window facing construction operations. ENGINEER's field office shall meet the following minimum requirements:
 - 1. Securely fixed to foundation
 - 2. Structurally sound and watertight
 - 3. Stairs and landings for doors as necessary
 - 4. Three hundred (300) square feet (28 m²)
 - 5. Three operable and locking windows with screens and storms.

6. Two locking, standard sized, entrance/exit doors
 7. Two telephone lines
 8. Two telephone jacks for each line
 9. One telephone
 10. One facsimile machine
 11. 120-volt electrical service per nec, complete
 12. One 36" x 42" (1m x 1.1m) drafting table
 13. One drafting stool
 14. One 30" x 60" (.75m x 1.5m) desk
 15. One four drawer locking file cabinet
 16. Two desk chairs
 17. One plan rack (minimum capacity eight plan sets)
 18. One first aid kit
 19. One 10A:80-B:C fire extinguisher
 20. Automatically controlled heating, ventilating, air conditioning system to maintain temperature between 68° and 76° Fahrenheit (20° and 25° Celsius) year-round.
- B. CONTRACTOR shall furnish and maintain bottled water and sanitary facilities for the field office. CONTRACTOR shall clean the office at least once per week. CONTRACTOR shall provide and pay for utility service throughout the duration of the Project, including telephone service and long-distance telephone service.
- C. A trailer having equal facilities and floor space may be used in place of the above described field office if so desired.
- D. The field office shall be furnished with a minimum of an aggregate surfaced driveway and parking area, for the exclusive use of ENGINEER, for at least three (3) vehicles.
1. CONTRACTOR shall maintain parking area including snow removal.
- E. Cost for furnishing and installing the field office, for furnishing utilities and utility service, and for maintenance of the field office and facilities, unless otherwise specified in the Proposal, will not be paid for separately but shall be included in the price bid for various items of Work under the Contract.
1. The building shall be removed by the CONTRACTOR upon completion of the Contract and shall become his property.

1.19 Bypass Pumping

- A. CONTRACTOR shall maintain flow in existing sewers at all times by pumping, bypassing, or fluming as necessary.
1. During wet weather events, the flow in the sewer will rise rapidly and may become surcharged.
 2. CONTRACTOR shall maintain flow in such a manner as the existing flow can be adequately transported including wet weather flow.
 3. CONTRACTOR shall furnish, install, operate, and maintain temporary pumping facilities to service the upstream area including piping, temporary channels, pumps, sumps, controls, temporary plugs, and bulkheads.
- B. For sanitary sewerage, by-pass piping shall be PVC Schedule 80, ABS truss pipe, or equivalent with solvent welded joints, or HDPE with butt fused joints.

1. Flexible hoses of whatever types are not acceptable.
 2. By-passed flow shall be discharged to a sanitary sewer of acceptable size to handle the bypassed and existing flows.
 3. CONTRACTOR shall plan his operation such that there will be no backups, leaks, or discharges of pollutants.
- C. CONTRACTOR shall also furnish and have available onsite, redundant pumping facilities in case of any failure of the pumping system including pumps, piping, electrical, connections, etc.
1. Redundant pumping facilities also include having a backup power generator in case the primary power source fails.
 2. CONTRACTOR shall provide an adequate labor force to oversee the by-pass pumping including providing labor to maintain 24 hour per day operation and emergency backup service.
- D. Costs for pumping and bypassing flow shall be included in the unit price bid for other items of Work unless otherwise specified in the Proposal.
- E. CONTRACTOR shall submit a by-pass pumping/diversion scheme to ENGINEER for approval not less than 15 days prior to any anticipated bypass pumping/diversion. Bypass plan shall include pumping capacity and expected flow rates.

Part 2 Products

2.01 Barricades, Arrow Boards, Temporary Pavement Markings, and Temporary Signs

- A. Barricades, Arrow Boards, Temporary Pavement Markings, Temporary Signs, and other traffic control devices shall be in accordance with the current edition of the MDOT Standard Specifications for Construction, and the current edition of the Michigan Manual of Uniform Traffic Control Devices.

Part 3 Execution (Not Used)

End of Section

Section 01 5713

Temporary Erosion and Sediment Control

Part 1 General

1.01 Scope of Work

- A. This Section includes furnishing, installing, maintaining, and removing at project completion, Soil Erosion and Sedimentation Control devices. Devices include silt fence, straw bales, turbidity barriers, temporary gravel construction entrance/exits, inlet filters, ditch sediment traps, etc.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200: Unit Prices
- B. Section 01 8900: Site Construction Performance Requirements
- C. Section 31 2200: Grading
- D. Section 31 2313: Subgrade Preparation
- E. Section 31 2319: Dewatering
- F. Section 31 2333: Trenching and Backfilling
- G. Section 31 3500: Slope Protection
- H. Section 32 9219: Seeding
- I. Section 32 9223: Sodding
- J. Section 33 1100: Water Utility Distribution Piping
- K. Section 33 3000: Sanitary Utility Sewerage Piping
- L. Section 33 3400: Sanitary Utility Force Mains
- M. Section 33 4100: Storm Utility Drainage Piping

1.03 Reference Standards

- A. ASTM American Society for Testing and Materials

1.04 Requirements of Regulatory Agencies

- A. CONTRACTOR, at his expense, shall secure all permits, and post all bonds or deposits required to comply with the "Soil Erosion and Sedimentation Control," requirements, being Part 91 of PA 451 of 1994 as amended and the National Pollution Discharge Elimination System (NPDES) Rules for storm water discharges from construction activity.
- B. Comply with requirements of the agency having jurisdiction. OWNER may withhold payment to CONTRACTOR equivalent to any fines resulting from non-compliance with applicable regulations.

1.05 Performance Requirements

- A. Employ Best Management Practices as defined by standard EPA 832-R-92-005.
- B. Put preventative measures in place as soon as possible after disturbance of surface cover and before precipitation occurs.
- C. Control increased storm water runoff due to disturbance of surface cover due to construction activities for this Project.

- D. Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this Project.
- E. Prevent runoff into storm and sanitary sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less. Anticipate runoff volume due to the most extreme short term and 24-hour rainfall event that might occur in 10 years.
- F. Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this Project. Prevent windblown soil from leaving the project site. Comply with fugitive dust ordinances of agencies having jurisdiction. Prevent tracking or flowing of mud and sediment onto public or private roads, sidewalks or pavements outside of the site.
- G. Prevent sedimentation of waterways on or off the project site, including rivers, streams, lakes, ponds, open drainage ditches, storm sewers, and sanitary sewers. If sedimentation occurs, install or correct preventative measures immediately at no cost to OWNER. Comply with requirements of agencies having jurisdiction.
- H. Maintain temporary preventative measures until permanent measures have been established. Remove temporary measures when permanent measures have been established.
- I. If erosion or sedimentation occurs due to non-compliance with these requirements, remove deposited sediment or restore eroded areas at no cost to OWNER.

1.06 Submittals

- A. Submit schedule of Soil Erosion and Sedimentation Control activities to agency having jurisdiction. Include events (with days and/or dates of the various activities) for review and approval prior to obtaining a permit.
- B. CONTRACTOR must provide evidence of Storm Water Operator license.

Part 2 Products

2.01 Silt Fence

- A. Polypropylene geotextile fabric, resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; meeting the following requirements:
 - 1. Average Opening Size: 30 U.S. Std. Sieve 600 μm), maximum; ASTM D4751.
 - 2. Permittivity: 0.05 sec^{-1} , minimum; ASTM D4491.
 - 3. Ultraviolet Resistance: Retaining at least 70% of tensile strength; ASTM D4355 after 500 hours exposure.
 - 4. Tensile Strength: 100 lb-f (445 N) minimum, in cross-machine direction; 124 lb-f (551 N) minimum in machine direction; ASTM D4632.
 - 5. Elongation: 15 to 30%; ASTM D4632.

6. Tear Strength: 55 lb-f (244 N) minimum; ASTM D4533.
- B. Posts shall be 2 by 2-inch (50 mm x 50 mm) cross section hardwood stakes, minimum 3-feet (1.0 m) long.

2.02 Turbidity Barrier

- A. Geotextile fabric curtain suspended from flotation devices at the water surface and held in a vertical position by a ballast chain in the lower hem. Turbidity barrier curtain shall meet the following minimum requirements unless otherwise specified on the plans.
1. Consist of vinyl laminate on 1000 denier polyester fabric weighing 18 ounce per square yard (610 g/m²) minimum.
 2. Tensile strength of fabric shall be 220 lbs (100 kg) minimum.
 3. Edges of fabric to be reinforced with minimum 5/8-inch (16 mm) diameter polypropylene rope.
 4. Ballast chain minimum 5/16-inch (8 mm) galvanized steel.
 5. Buoyancy blocks providing buoyancy of 18lbs/l.f (27 kg/m).
 6. Length of curtain (water depth) 5-feet (1.5 m).

2.03 Dewatering Discharge Filter Bag

- A. UV-stabilized, non-woven geotextile bag to filter sediment from water prior to discharging. Geotextile fabric shall meet the following minimum average roll requirements:
1. Tensile Strength: 180 lb-f (200 N) minimum; ASTM D4632
 2. Elongation: 50 percent minimum; ASTM D4632
 3. CBR Puncture Strength: 300 lb-f minimum; ASTM D6241
 4. Trapezoidal Tear: 70 lb-f (310 N) minimum; ASTM D4533
 5. Flow Rate: 80 gal/min/sf. (54 l/s/m²) Minimum; ASTM D4491
 6. Permittivity: 1.4 sec⁻¹ minimum; ASTM D4491
 7. Apparent Opening Size: 80 U.S. Std. Sieve maximum; ASTM D4751
 8. UV-Stability: 70% retained strength; ASTM D4355 after 500 hours.

2.04 Erosion Control Blankets

- A. Machine produced blanket with a consistent thickness of evenly distributed straw or coconut fiber as specified. Unless otherwise specified on the Plans, the erosion control blanket shall have the following minimum properties:
1. Double net 100% straw blanket.
 2. Top and bottom photodegradable polypropylene netting, 1.64 lbs./1,000 sf. (0.8 kg/ m²) approximate weight.
 3. 100% agricultural straw 0.5 lbs/sy (.27 kg/m²).
 4. Stitch spacing: 1.5 inches (40 mm) on centers.

- B. Pegs shall be 6-inch (150 mm) long, hardwood pegs.

2.05 Bonded Fiber Matrix

- A. Bonded fiber matrix (BFM) shall consist of long strand, residual, softwood fibers joined together by a high-strength, non-toxic adhesive. BFM shall be 100% biodegradable, and be non-toxic to fish, wildlife, and humans. Upon drying the matrix shall form a high strength, porous and erosion resistant mat that shall not inhibit the germination and growth of plants. BFM shall retain its form despite re-wetting.
- B. Bonded fiber matrix shall consist of:
 - 1. Seed and Fertilizer per Section 32 9219, Seeding.
 - 2. Wood Fiber Mulch: Thermo-mechanically defibrated long, softwood fibers manufactured from select northern softwood wood chips.
 - 3. Polyacrylamide Binder: Site specific, fully biodegradable, polyacrylamides (PAM's) binders, with cross-linking long organic jute fibers
- C. Materials shall be mixed at the rate of 80 lbs/acre (90 kg/Ha) of PAM binder and 2500 lbs/acre (2800 kg/Ha) of wood fiber mulch.

2.06 Inlet Filter Fabric

- A. Filter fabric shall be constructed of 100% continuous polyester needle-punched non-woven engineering fabric. Filter fabric shall be fabricated to provide a direct fit with the drainage structure cover. Filter fabric shall have the following minimum physical properties.
 - 1. Tensile Strength: 80 lb-f (.355 kN) minimum; ASTM D4632
 - 2. Elongation: 50 percent minimum; ASTM D4632
 - 3. CBR Puncture Strength: 300 lb-f, minimum; ASTM D6241
 - 4. Trapezoidal Tear: 70 lb-f (310 N) minimum; ASTM D4533
 - 5. Flow Rate: 80 gal/min/sf. (54 l/s/m²) Minimum; ASTM D4491
 - 6. Permittivity: 1.4 sec⁻¹ minimum; ASTM D4491
 - 7. Apparent Opening Size: 100 U.S. Std. Sieve (150 µm) maximum; ASTM D4751
 - 8. UV-Stability: 70% retained strength; ASTM D4355 after 500 hours.

2.07 Acceptable Manufacturers

- A. Acceptable manufacturers include the following:
 - 1. Turbidity Barrier: Tough Guy Type II by Aer-flo Canvas Products, Inc.
 - 2. Wood Fiber Mulch: EcoFibre by Canfor Corporation.
 - 3. Polyacrylamide Binder: HydroTurboNet by Straw Net, Inc.

Part 3 Execution

3.01 Examination

- A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to the greatest extent possible.

- B. Except in areas to be cleared, do not remove, cut, deface, injure or destroy trees or shrubs without ENGINEER's approval. Protect existing trees or shrubs that are to remain, and which may be injured, bruised, defaced, or otherwise damaged by construction operations, with suitable fences or other means as approved by ENGINEER.

3.02 Preparation

- A. Review the drawings and Storm Water Pollution Prevention Plan (SWPPP).
- B. Revise SWPPP as necessary to address potential pollution from site identified after issuance of the SWPPP at no additional cost to Owner.
- C. Conduct storm water pre-construction meeting with Site Contractor, all ground-disturbing Subcontractors, site Engineer of record or someone from their office familiar with the site and SWPPP, and state or local agency personnel in accordance with requirements of the special conditions.
- D. Schedule work so that the soil surfaces are left exposed for the minimum amount of time. Place permanent soil and sedimentation control measures as soon as practical.

3.03 General

- A. Do not discharge excavation ground water to the sanitary sewer, storm sewer, or to rivers, streams, etc. without authorization from the agency having jurisdiction. Construction site runoff will be prevented from entering any storm drain, river, stream, etc. directly by the use of silt fences or other suitable methods. CONTRACTOR shall provide erosion protection of surrounding soils.
- B. Sedimentation control devices shall be installed prior to CONTRACTOR beginning Work. Soil erosion and sedimentation control devices shall be maintained in an effective functioning condition at all times during the course of the Work.
- C. Immediately bring earthwork to final grade and protect sideslopes and backslopes from erosion. Plan and conduct earthwork to minimize duration of exposure of unprotected soils.

3.04 Installation - General

- A. Install silt fences, ditch sediment traps, check dams, inlet filters, temporary gravel construction entrance/exits, turbidity barriers, erosion control blankets and other soil erosion control devices in accordance with the drawings and Storm Water Pollution Prevention Plan, or as may be dictated by site conditions in order to maintain the intent of the specifications and permits.
- B. Deficiencies or changes on the drawings or SWPP shall be corrected or implemented as site conditions change. Changes during construction shall be noted in the SWPP and posted on the drawings.
- C. OWNER has authority to limit surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and embankment operations and to direct CONTRACTOR to provide immediate permanent or temporary pollution control measures.

- D. Remove temporary control devices after permanent measure are established. Remove and replace temporary control devices if they become ineffective at no additional cost to OWNER.
- E. CONTRACTOR shall incorporate permanent erosion control features, paving, permanent slope stabilization, and vegetation into project at earliest practical time to minimize need for temporary controls.
- F. CONTRACTOR shall permanently seed and mulch cut slopes as excavation proceeds to extent considered desirable and practical.

3.05 Dust Control

- A. Keep dust down at all times, including during non-working periods. Sprinkle or treat, with dust suppressants, the soil at the site, haul roads, and other areas disturbed by operations. Dry power brooming is not permitted.

3.06 Installation of Erosion Control Blankets

- A. Erosion control blankets shall be pegged at the pattern and rate as recommended by the manufacturer, however, at a minimum, blankets shall be pegged at the rate of 1.75 pegs per square yard (2pegs/m²) of blanket, unless otherwise indicated on the plans.

3.07 Application of Bonded Fiber Matrix

- A. The slope shall be prepared and graded prior to application of bonded fiber matrix (BFM). Mixture of wood fiber mulch and polyacrylamide binder shall be blended, with the appropriate amount of seed and fertilizer per Section 32 9219, Seeding, according to manufacturer's recommendations.
- B. BFM shall be hydraulically applied to the soil as a viscous mixture, crating a continuous, three-dimensional blanket that adheres to the soil surface. BFM shall be mixed and applied at the rate as specified in Article 2.06 unless otherwise indicated on the Plans.
- C. The resulting coverage must be at least 1/8 inch (3 mm) thick over the entire surface area. BFM shall be applied in two applications from alternate directions to eliminate shadowing and shall be applied when no rain is expected for 12 hours.

3.08 Dewatering Discharge

- A. Should it be necessary for CONTRACTOR to do any dewatering during the course of construction, CONTRACTOR shall filter all discharge through a discharge filter bag or other sediment control device that will filter all discharge water.
- B. No dewatering discharge shall be allowed to flow unfiltered from the construction site.

3.09 Maintenance

- A. Maintain temporary erosion and sedimentation control systems as dictated by site conditions, indicated in the construction documents, or as directed by governing authorities or OWNER to control sediment until final stabilization.

- B. CONTRACTOR shall respond to maintenance or additional work ordered by OWNER or governing authorities immediately, but in no case, within not more than 48 hours if required at no additional cost to OWNER.

3.10 Inspection

A. General:

1. CONTRACTOR is responsible to obtain and/or serve as the Certified Operator.
2. Weekly inspections are to be conducted by CONTRACTOR as a minimum, and after every rainfall event. A copy of the inspection report shall be submitted to the agency having jurisdiction, as well as OWNER and ENGINEER.
3. Inspections shall be performed by a person familiar with the site, the nature of the major construction activities, and qualified to evaluate both overall system performance and individual component performance.
4. Inspector must either be someone empowered to implement BMPs in order to increase effectiveness to an acceptable level or someone with the authority to cause such things to happen.
5. Inspector must be certified as a "Storm Water Professional" through the MDEQ storm water training program. Additionally, the inspector shall be properly authorized in accordance with the applicable General Permit to conduct the certified site storm water inspections.

B. Inspection Frequency Reduction:

1. Inspection frequency may be reduced under the following conditions:
 - a. No active onsite construction activities.
 - b. Temporary cover has been provided across the entire site and no BMPs remain. Situation: waiting for grass to grow, but grass is dormant.
 - c. Ground is frozen and/or snow covered.
2. Weekly Storm Water Meeting:
 - a. A weekly storm water meeting will be held by CONTRACTOR with those involved in ground-disturbing activities to review the requirements of the permits, the SWPPP, and address any problems that have arisen in implementing the SWPPP or maintaining the BMPs.
 - b. CONTRACTOR shall maintain a log of weekly meetings and document the issues addressed in the meetings on site.
3. Agency Storm Water Inspections:
 - a. A log of inspections by federal, state, or local storm water or other environmental agencies shall be kept in CONTRACTOR's SWPPP.

- b. The log form should include the date and time of visit and whether a report was issued or will be issued as a result of the inspection.
- c. Any reports issued will be sent to ENGINEER within 24 hours.

3.11 Project Completion

- A. Remove temporary soil erosion and sedimentation control devices as soon as permanent measures have been established.

End of Section

Section 01 6000 Product Requirements

Part 1 General

1.01 Transportation and Handling

- A. CONTRACTOR shall provide for expeditious transportation and delivery of materials and equipment to the Project site in an undamaged condition and on a schedule to avoid delay of the Work. Materials and equipment shall be delivered in original containers or packaging with identifying labels intact and legible.
- B. CONTRACTOR shall provide equipment and personnel at the site to unload and handle materials and equipment in a manner to avoid damage. Materials and equipment shall be handled only at designated lifting points by methods to prevent bending or overstressing.

1.02 Storage and Protection

- A. CONTRACTOR shall store materials and equipment immediately on delivery and protect it until installed in the Work.
- B. Products subject to damage by elements shall be stored in weather-tight enclosures with temperature and humidity ranges as required by manufacturer's instructions.
- C. Loose granular materials shall be stored on solid surfaces to prevent mixing with foreign matter.
- D. The place of storage shall be located so as to minimize interference with traffic and to provide easy access for inspection. No material shall be stored closer than five (5) feet (1.5 m) to the edge of a pavement or traveled way open to the public.
- E. Materials that have been stored shall be subject to retest and shall meet the requirements of their respective specifications at the time they are to be used in the Work.
- F. CONTRACTOR shall provide protection of stored or installed materials and equipment as necessary to prevent damage from traffic and subsequent operations.

1.03 Manufacturer's Instructions

- A. When the Contract Documents require that installation of Work shall comply with manufacturer's instructions, CONTRACTOR shall obtain and distribute copies of such instructions to parties involved in the installation including two (2) copies to ENGINEER.
- B. CONTRACTOR shall handle, install, connect, clean, condition and adjust products in strict accord with such instructions and in conformity with specified requirements. Should Project conditions or specified requirements conflict with manufacturer's instructions, consult with ENGINEER for further instructions.

1.04 Products List

- A. Within four (4) days of request, CONTRACTOR shall submit a complete list of major products proposed to be used, with the name of the manufacturer and the installing subcontractor, if applicable, to ENGINEER.

1.05 CONTRACTOR's Product Options

- A. For products specified only by reference standard, CONTRACTOR shall select any product meeting that standard.
- B. For products specified by naming several products or manufacturer's CONTRACTOR shall select any one of the products or manufacturers named, which complies with the specifications.
- C. For products specified by naming one or more products or manufacturers and "or equal," CONTRACTOR must submit a Substitution Request Form for any product or manufacturer not specifically named, in accordance with the General Conditions.
- D. For products specified by naming only one product and manufacturer, there is no option.

1.06 Equipment Startup and Testing

- A. CONTRACTOR shall perform a comprehensive startup and demonstration of equipment performance and compliance with the design requirements. When there is more than one mode of operation, the equipment shall be operated in every mode to verify proper operation.
- B. When equipment is to operate in conjunction with other equipment as a system, each piece of equipment shall be operated both by itself and automatically as a system to verify its proper operation.
- C. CONTRACTOR is to provide to ENGINEER, in advance of startup, a schedule and listing of startup and testing procedures for review by ENGINEER. Checklists and diagrams may be required to ensure adequate startup and testing. ENGINEER may recommend changes to the startup procedure as necessary.
- D. Equipment is to be inspected prior to operation for debris or other obstructions. Equipment is to be properly lubricated and calibrated prior to operation. CONTRACTOR shall make all adjustments necessary to assure correct operation. When required, equipment installation and operation is to be witnessed and checked by manufacturer.
- E. When required, CONTRACTOR shall train OWNER's operation and maintenance personnel in the proper operation and maintenance of each piece of equipment and the system as a whole.
- F. Equipment startup is to be witnessed by OWNER and ENGINEER.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

End of Section

Section 01 7123 Construction Layout

Part 1 General

1.01 Responsibility for Staking

- A. OWNER will set stakes and markers showing the locations on the surface of various parts of the Work as outlined herein. Additional stakes shall be provided at the expense of CONTRACTOR.
- B. CONTRACTOR shall furnish such labor and assistance as OWNER may require in setting the same.
- C. It shall be the responsibility of CONTRACTOR to transfer surface line and grade to the bottom of any tunnel or to the bottom of any other subsurface operations where ordinary surface line and grade is not feasible.
- D. CONTRACTOR shall utilize lasers, or surveying instruments run by qualified competent personnel to control the construction installation Work. If the method being used by CONTRACTOR fails to give proper alignment and grade control to the Work, OWNER shall be empowered to order the CONTRACTOR to use such other method(s) as will provide adequate control.
- E. ENGINEER may require CONTRACTOR, at CONTRACTOR's expense, to provide such masts, scaffolds, batter-boards, straightedges, templates, or other devices as may be necessary to facilitate laying out, observing and constructing the Work.

1.02 Staking Schedule

- A. CONTRACTOR shall submit a completed staking schedule on the form provided by ENGINEER showing the order in which CONTRACTOR proposes to conduct the construction operation prior to the preconstruction meeting. The schedule shall be submitted to ENGINEER a minimum of three (3) working days prior to the start of construction.
- B. During construction CONTRACTOR shall to the extent possible, limit unnecessary staking requests and coordinate his construction schedule to provide for the efficient and effective use of the survey crew and eliminate excessive survey crew trips to the site.

1.03 Line and Grade

- A. CONTRACTOR shall request, three (3) working days in advance, from ENGINEER additional line and grade stakes as CONTRACTOR may reasonably protect and preserve. Such request by CONTRACTOR shall be on a staking request form.

1.04 Relocation and Re-Establishment

- A. Construction Stakes:
 - 1. Where change of location of stakes has been requested by CONTRACTOR, or where CONTRACTOR fails to properly preserve construction survey stakes, such resetting or relocations of stakes shall be done by ENGINEER and paid for by CONTRACTOR on the basis of time and materials for such restaking.

B. Survey Control Points:

1. CONTRACTOR shall bear all expense involved in re-establishing and/or resetting any survey control point, land survey point or monument lost or disturbed during his construction operation. Such Work shall be done under the direct supervision of a licensed land surveyor. Such survey control points shall be marked and flagged by ENGINEER prior to construction.

1.05 Staking Pipelines Laid to Grade

- A. One (1) staking: Line and grade points at each structure and at not less than 100-foot (30 m) intervals, with benchmarks at maximum 1/4-mile (400 m) intervals.

1.06 Staking Pipelines Not Laid to Grade

- A. One (1) staking: Line points at each structure with 100-foot (30 m) intermediate line points.

1.07 Staking Tunnels

- A. First staking: Line and grade to sink the shaft.
B. Second staking: Line and grade on top of the shaft prior to tunneling.

1.08 Staking Bores

- A. One (1) staking: Line and grade points at each end.

1.09 Staking Existing Drainage

- A. Unless otherwise indicated on the Plans or specified herein, CONTRACTOR shall bear all expenses including the staking of line and grade required to restore proper grading of surface drainage, including swales and ditches disturbed during the construction operation.

1.10 Staking Earth Work

- A. Parks, Parking Lots, or Site Improvement:
1. First staking: Line points at 300-foot (100 m) intervals for clearing and grubbing.
 2. Second staking: Final grade points on 100-foot (30 m) grid and grade changes.
- B. Site Improvement Paving:
1. First staking: Line points at 300-foot (100 m) intervals for clearing and grubbing.
 2. Second staking: Final grade points at 50-foot (20 m) intervals on centerline, perimeter and at grade changes.
- C. Ponds:
1. First staking: Line points at 300-foot (100 m) intervals for clearing and grubbing.
 2. Second staking: Perimeter dike or bank alignment points offset at corners with two (2) benchmarks onsite.

1.11 Staking Open Drains

- A. New Drain Improvements:

1. First staking: Line points at 300-foot (100 m) intervals and angle points for clearing and grubbing.
 2. Second staking: Line and grade points at 100-foot (30 m) intervals, angle points, grade changes, and structures.
- B. Drain Cleanouts:
1. One (1) staking of grade points at 300-foot (100 m) intervals, angle points, grade changes, and structures.

1.12 Staking Roadway Without Curb and Gutter

- A. One (1) staking: Line and grade points for road centerline finish surface at 50-foot (20 m) intervals and at grade changes, points of curve and at 25-foot (10 m) intervals on curves.

1.13 Staking Roadway with Curb and Gutter

- A. One (1) staking: Line and grade points for top of curb at 50-foot (20 m) intervals and at grade changes, points of curve and at 25-foot (10 m) intervals on curves.

1.14 Staking Buildings and Structures

- A. One (1) staking: Two (2) intersecting base lines and a minimum of two benchmarks on the site.
- B. Two (2) benchmarks each side of watercourse to be provided for bridges.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

End of Section

Section 01 7700 Closeout Procedures

Part 1 General

1.01 Cleaning

- A. CONTRACTOR shall perform periodic cleaning to keep the Work, the site and adjacent properties free from accumulations of waste materials, rubbish and wind-blown debris, resulting from construction operations.
- B. Waste material, debris and rubbish shall be periodically removed from the site and disposed of at legal disposal areas away from the site.
- C. Prior to OWNER acceptance CONTRACTOR shall conduct an inspection of sight-exposed interior and exterior surfaces, and all Work areas, to verify that the entire Work is clean.
- D. CONTRACTOR shall broom clean exterior paved surfaces and rake clean other exterior surfaces of the site.
- E. Clean and repaint with matching color scratched, marred or otherwise damaged painted surfaces of equipment and enclosures.

1.02 Project Record Documents

- A. On completion of the Work, prior to CONTRACTOR's application for final payment, and as a condition to its approval by ENGINEER and OWNER, CONTRACTOR shall arrange such site records in order in accordance with the various sections of the specifications bind them together and index them and deliver them to ENGINEER.
- B. CONTRACTOR shall request a complete set of reproducible Contract Drawings, and transfer all as-built revisions and changes to them and deliver them to the ENGINEER. These drawings shall be dated and marked "RECORD DOCUMENTS".
- C. Reproducible tracings made by CONTRACTOR, Subcontractors, equipment manufacturers, and/or Suppliers shall be corrected to show the Work as actually completed or installed and a reproducible copy of these drawings shall then be turned over to ENGINEER.
- D. Written approval or other evidence satisfactory to ENGINEER of the final conditions of the work shall be obtained from:
 - 1. Public authorities or agencies having jurisdiction over any portion of the work
 - 2. Others as requested by ENGINEER in writing.
- E. 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.
- F. CONTRACTOR shall deliver one (1) copy of all Specifications, Plans, Addenda, Shop Drawings, Samples, Certificates, approvals, etc. annotated to show all changes made during the construction process, to ENGINEER upon completion of the Work and prior to CONTRACTOR's application for final payment. Submittal of the record documents shall be made with a transmittal letter containing:

1. Date
2. Project Title and Number
3. CONTRACTOR's Name and Address
4. Title and Number of each Record Document
5. Certification that each Document as submitted is complete and accurate
6. Documents shall be submitted in good order and in a legible condition.

1.03 Operation and Maintenance Data

- A. Prior to final inspection or acceptance, CONTRACTOR shall fully instruct OWNER's designated operating and maintenance personnel in the operation, adjustment and maintenance of all products, equipment and systems specified.
- B. Operation and maintenance data required by the individual Specification sections and the manufacturer's operation and maintenance data required in Section 01 3300, Submittal Procedures, shall constitute the basis of such instruction.

1.04 Spare Parts and Special Tools

- A. Spare Parts:
 1. As soon as practicable after approval of the list of equipment, CONTRACTOR shall furnish spare parts data for each different item of equipment listed. The data shall include a complete list of parts and supplies with current unit prices and source of supply.
 2. CONTRACTOR shall also furnish a list of parts and supplies that are either normally furnished at no extra cost with the purchase of the equipment or specified to be furnished a part of the Contract and a list of additional items recommended by the manufacturer to assure efficient operation for a period of one (1) year at the particular installation.
 3. The foregoing shall not relieve CONTRACTOR of any responsibilities under the guarantee provisions of these Specifications.
 4. CONTRACTOR shall deliver all spare parts required by this contract to ENGINEER or as directed by ENGINEER.
- B. Special Tools:
 1. CONTRACTOR shall furnish at no additional cost to OWNER with each piece of equipment, one complete set of suitably marked special tools and appliances which may be needed to adjust, operate, maintain, or repair the equipment.
 2. CONTRACTOR shall submit for approval by ENGINEER a complete list of the special tools and appliances to be furnished. Such tools and appliances shall be furnished in approved painted steel cases properly labeled and equipped with good grade cylinder locks and duplicate keys.
 3. CONTRACTOR shall deliver all special tools required by this contract to ENGINEER or as directed by ENGINEER.

1.05 Start Up

- A. Equipment start-up period for the training of plant personnel shall begin after satisfactory completion and acceptance of the field tests and coincidentally with the certified date of substantial completion for that part of the work for which the equipment is included. If the equipment is not covered by a certificate of substantial completion for a part of the work, the period shall begin upon substantial completion of the project.
- B. During the equipment start-up period, CONTRACTOR shall furnish at no additional cost to OWNER the services of factory trained representatives of the equipment manufacturers for the equipment designated in the Specifications to:
 - 1. Assist in the start-up and operations of the equipment.
 - 2. Assist in the training of facility personnel, designated by OWNER, in the proper operation and maintenance of the equipment.
- C. OWNER shall:
 - 1. Provide the necessary personnel to be instructed in the operation and maintenance of the equipment. OWNER's personnel shall operate all equipment.
 - 2. Pay for all fuel, power and chemicals consumed beyond quantities specified or in the Contract Documents or required due to CONTRACTOR's fault. CONTRACTOR shall pay for fuel, power, and chemicals consumed up to the date of "certified substantial completion" except as otherwise specified herein.
- D. CONTRACTOR shall be available to promptly repair all work during the start-up period so as to cause minimum disruption to the total facility operation.
- E. In the event a system, equipment, or component proves defective or is unable to meet specified performance criteria, CONTRACTOR shall replace the defective item and the one (1) year guarantee period for the item shall start after satisfactory replacement and testing of the item.

1.06 Substantial Completion

- A. When CONTRACTOR considers that the Work, or portion thereof which the OWNER agrees to accept separately, is substantially complete, the CONTRACTOR shall prepare and submit to ENGINEER a comprehensive list of items to be completed or corrected.
- B. CONTRACTOR shall proceed promptly to complete and correct items on the list. Failure to include an item on such list does not alter the responsibility of CONTRACTOR to complete all Work in accordance with the Contract Documents.
- C. Upon receipt of CONTRACTOR's list, ENGINEER will make an inspection to determine whether the Work or designated portion thereof is substantially complete.
- D. If ENGINEER's inspection discloses any item, whether or not included on CONTRACTOR's list, which is not in accordance with the requirements of the Contract Documents, CONTRACTOR shall complete or correct such item upon notification by ENGINEER. CONTRACTOR shall then submit a request for another inspection by ENGINEER to determine Substantial Completion.

- E. When the Work or designated portion thereof is substantially complete, ENGINEER will prepare a Certificate of Substantial Completion which shall establish responsibilities of OWNER and CONTRACTOR for security, maintenance, heat, utilities, damage to the Work and insurance, and shall fix the time within which the CONTRACTOR shall finish all items on the list accompanying the Certificate. The Certificate of Substantial Completion shall be submitted to OWNER and CONTRACTOR for their written acceptance of responsibilities assigned to them in such Certificate.
- F. Warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work or designated portion thereof unless otherwise provided in the Certificate of Substantial Completion.

1.07 Warranties

- A. CONTRACTOR shall submit duplicate copies of all warranties prior to final Application for Payment. CONTRACTOR shall also execute, assemble and submit transferable warranty documents from Subcontractors, suppliers, and manufacturers.
- B. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within ten (10) days after acceptance, listing date of acceptance as start of warranty period.
- C. All parts of the work or equipment which is in the opinion of ENGINEER prove defective in material, workmanship, or operation within the warranty period shall be removed and replaced or repaired in a manner satisfactory to ENGINEER and at no cost to OWNER.
- D. Service material or equipment required because of the defect shall be supplied without charge.
- E. Work specified to be designed by CONTRACTOR shall be guaranteed to perform as specified.
- F. Warranty period shall be one year from 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 one (1) year from said takeover and use.
- G. Equipment or work replaced and/or repaired during the warranty period shall be guaranteed for one year from the date of acceptance of the repair or replacement or until expiration of the original warranty period whichever comes later.

1.08 Final Payment and Acceptance

- A. The final inspection, final application for payment and acceptance shall be in accordance with the General Conditions.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

End of Section

Section 01 7900 Demonstration and Training

Part 1 General

1.01 Requirements Included

- A. Instruct and train OWNER's personnel in maintenance and operation of equipment for systems supplied and/or installed under this Contract, including the following items:
 - 1. Process, mechanical, service and other equipment as noted in the detailed specifications.
 - 2. System instrumentation.
 - 3. Primary switchgear.
 - 4. Motor control centers.
- B. Incorporate the following maintenance and operation data and training services into the training program:
 - 1. Shop Drawings.
 - 2. Equipment Operation and Maintenance Manuals.
- C. Prepare instruction training materials, and student notes/guides for complete classroom and hands-on training of all individuals requiring training.

1.02 Related Requirements

- 1. Section 01 3300: Submittal Procedures
- 2. Section 01 7700: Closeout Procedures
- 3. Section 11 0500: Common Work Results for Equipment
- 4. Division 26, Electrical
- 5. Division 40, Process Interconnections

1.03 Quality Assurance

- A. Preparations of training materials and instruction to be provided shall be performed by personnel trained and experienced in maintenance and operation of equipment and systems to be installed under this Contract.

1.04 Schedule of Conducting Training

- A. Classroom and field training programs shall be conducted after performance testing begins but prior to substantial completion.
- B. Training programs shall be planned and conducted for:
 - 1. Operations Personnel.
 - 2. Maintenance Personnel.

- C. All scheduling shall be coordinated through ENGINEER.

1.05 Training for Maintenance of Instrumentation

- A. Train OWNER's maintenance personnel as follows:
 - 1. Describe the overall function of each instrument and control loop installed under this Contract.
 - 2. Locating the probable source of malfunction in the instrumentation equipment and control loops, determining the symptoms of the trouble, establishing the probable cause and effecting a solution.
 - 3. Taking appropriate, preventive, and corrective maintenance procedures necessary to keep the instrumentation system in proper operating condition, including calibration and testing.
- B. Course materials to be used for training OWNER's maintenance personnel shall include pertinent portions of the submittals specified in the Specifications such as loop diagrams, calibration data, trouble-shooting guides and maintenance instructions.
- C. The training program shall not include the time required for system start-up instructions or the field acceptance test.

1.06 Training for Electrical and Mechanical Maintenance

- A. Train OWNER's maintenance personnel as follows:
 - 1. Describe the functions of the equipment installed under this Contract.
 - 2. Component preventive and corrective maintenance activities required to keep unit equipment in good operating conditions.
 - 3. The Contractor shall instruct the personnel in locating the probable source of equipment malfunctions, determining the symptoms of the trouble, establishing the probable cause, and effecting a solution.
- B. Course materials to be used for training OWNER's electrical and mechanical maintenance personnel to include pertinent portions of the operation and maintenance manuals as well as alignment tolerances, lubrication schedules, vibration analysis instruction and parameters, trouble-shooting guides and special calibration test and procedures.
- C. Method of training electrical and/or mechanical maintenance personnel shall include CONTRACTOR using OWNER's equipment to demonstrate troubleshooting, preventive and corrective maintenance procedures.
- D. The field training program shall not include the time required for system start-up instructions or the acceptance test.

1.07 Operational Training

- A. Train OWNER's operations personnel as follows:

1. Describe the functions of the equipment installed under this Contract, including how the components of a system are controlled together and what the effects of the control methods are on the system and on other upstream and downstream processes installed under this Contract.
 2. Implement start-up and shutdown procedures for each piece of equipment individually, as well as the start-up and shutdown of the systems comprising the equipment. This instruction shall include normal operation, alternative operations, and emergency operations.
 3. Understand the functions of the equipment installed under this Contract, describing the individual components and how each component is used in monitoring and/or controlling equipment and/or processes installed under this Contract.
 4. Discuss the operating modes possible as a result of the modifications and installations made under this Contract.
 5. Locating the probable source of system trouble determining the symptoms, establishing the probable cause, and re-stabilizing system efficiency or systems installed under this contract.
 6. Demonstrate necessary precautions for safe operation of the equipment, instrumentation, and control system installed under this Contract.
 7. Demonstrate emergency procedures for equipment and systems installed under this Contract.
- B. Course materials to be used for training OWNER's operation personnel include pertinent portions of the Operations and Maintenance Manuals, including start-up and shutdown procedures; descriptions of equipment and instrumentation functions and modes of operations, control and monitoring; trouble-shooting instructions and process control instructions.
- C. Methods of training OWNER's operations personnel shall include a field training program at OWNER's site consisting of classrooms and hands-on training using OWNER's equipment and systems.
- D. The field training program shall not include the time required for system start-up instructions or the field acceptance test.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

End of Section

Section 01 8813

Special Construction Performance Requirements

Part 1 General

1.01 Summary

- A. CONTRACTOR shall schedule and arrange Work so that the existing utilities and flows in the plant will remain in service, without interruption during construction activities. The Influent Structure must be bypassed and the entire Grit Battery A system can be taken out-of-service for the entire period of construction.
- B. CONTRACTOR shall be totally responsible for the construction of the Project under scheduling conditions outlined herein and any other scheduling which may be necessary.
- C. Work shall be completed for the lump sum price submitted in 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.
- D. CONTRACTOR shall note the construction site area limitations as they impact on storage of excavated and construction materials. CONTRACTOR shall make all necessary provisions for off-site storage as required for his operations. Costs for this work including permits, shall be included in CONTRACTOR's lump sum price bid. Prior to commencement of site excavation, CONTRACTOR shall provide the names and locations of the offsite disposal and storage area to be used for excess excavated materials.
- E. CONTRACTOR shall notify OWNER prior to any work being conducted outside of normal business hours and shall provide notification to OWNER's personnel when workers are on site.

1.02 Coordination

- A. Prior to commencing any work on any excavation of the site, temporary construction fencing shall be installed to protect the area. The temporary fence shall be 6'-0" high chain link fence. Fencing shall be removed when final grading and site restoration begins.
- B. Restoration of the site shall be done strictly according to the requirements of these plans and specifications, under the coordination and direction of a specialist in this field. CONTRACTOR is responsible for watering, fertilizing or other care required by the plantings for one year from the date of their acceptance by OWNER.
- C. Equipment and the facilities shall be tested with clean water prior to being accepted by OWNER. Testing shall be conducted in the presence of OWNER's representative. Equipment and the facilities shall then be cleaned and turned over to OWNER in good working order.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

End of Section

Section 01 8900

Site Construction Performance Requirements

Part 1 General

1.01 Scope of Work

- A. This Section includes general performance requirements for earthwork complete with, reimbursement for crop damage, removal and disposal of structures and obstructions, protection of existing sewers, tiles and mains; protection of existing building and improvements, protection of trees and other types of vegetation, protection of utility lines, requirements for pavement replacement, restoration of driveways and parking areas, restoration of sidewalks, restoration of lawns and disturbed areas, transportation, and disposal of excess excavation.

1.02 Related Work Specified Elsewhere

- A. Section 01 5713: Temporary Erosion and Sediment Control
- B. Section 31 2200: Grading
- C. Section 31 2313: Subgrade Preparation
- D. Section 31 2319: Dewatering
- E. Section 31 2316: Structural Excavation and Backfill
- F. Section 31 2333: Trenching and Backfilling
- G. Section 32 1216: Bituminous Paving
- H. Section 32 1313: Concrete Paving
- I. Section 32 1315: Sidewalks and Driveways
- J. Section 32 9219: Seeding
- K. Section 32 9223: Sodding

1.03 Reference Standards

- A. Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. MDOT - Michigan Department of Transportation Standard Specifications for Construction, latest edition.

1.04 Requirements of Regulatory Agencies

- A. CONTRACTOR shall comply with Section 01 5713, Temporary Erosion and Sediment Control. CONTRACTOR, at his expense, shall secure all permits, and post all bonds or deposits required to comply with the "Soil Erosion and Sedimentation Control," requirements, being Part 91 of PA 451 of 1994 as amended.
- B. CONTRACTOR shall comply with all requirements of the National Pollutant Discharge Elimination System (NPDES) Storm Water Program for Construction Activities, Part 31 of PA 451 of 1994 as amended.
- C. CONTRACTOR shall provide, maintain and remove such temporary and/or permanent soil erosion and sedimentation control measures as specified on the Plans or as determined by ENGINEER.

1. Measures shall prevent surface runoff from carrying excavated materials into the waterways, to reduce erosion of the slopes, and to prevent silting in of waterways downstream of the Work.
2. Measures should include provisions to reduce erosion by the wind of all areas stripped of vegetation, including material stockpiles.

1.05 Submittals

- A. Written permission for the use of all disposal and borrow sites shall be obtained and copies shall be furnished to ENGINEER.

1.06 Protection of Plant Life

- A. Trees, shrubs, and other types of vegetation not within the limits of the Work or not designated on the Plans or by ENGINEER to be removed, shall be carefully protected from damage or injury during the various construction operations.
- B. Any tree, shrub or other type of vegetation not designated to be removed but which is damaged by CONTRACTOR's operation shall be repaired or replaced by CONTRACTOR, at his expense, as determined by ENGINEER.

1.07 Protection of Existing Structures and Improvements

- A. existing culverts, sewers, drainage structures, manholes, water gate wells, hydrants, water mains, utility poles, overhead lines, underground conduits, underground cables, pavement, or other types of improvements within the construction limits, not designated on the Plans to be removed, shall be carefully protected from damage during the construction operations.
- B. Existing structure or improvement not designated to be removed, but which is damaged by CONTRACTOR's operations shall be repaired or replaced by the CONTRACTOR, to the satisfaction of the owner, at his expense.
- C. Deposits of dirt or debris in sewers, culverts, tiles, drainage structures, manholes, gate wells, etc. caused by CONTRACTOR shall be cleaned out at the CONTRACTOR's expense.

1.08 Maintaining Drainage

- A. Existing open drains, field and roadway ditches, drainage tile, sewers, enclosed drains, natural and artificial watercourses, surface drainage or any other types of drainage within the limits of the Work shall be maintained and free to discharge during construction.
- B. Drainage facility not designated to be abandoned, but which is damaged, or any drainage interrupted by the CONTRACTOR's operation shall be immediately repaired, replaced, or cleared by the CONTRACTOR.
- C. Costs incurred shall be incidental to the excavating, backfilling and compacting or grading operations.

Part 2 Products

2.01 Granular Material

- A. Bank run sand meeting the requirements of MDOT, Granular Material Class II.

2.02 Aggregate for Shoulders, Parking Areas, Driveways or Roads

- A. Crushed Limestone, Natural Aggregate or Slag and meeting the requirements of MDOT Section 902.

Part 3 Execution

3.01 Dewatering

- A. The area within the vicinity of the new Work shall be dewatered prior to commencing any construction activities. The depth of the dewatering shall be sufficient to allow the Work area to remain in a dry condition during the various construction operations.
- B. Costs incurred for furnishing, installing, maintaining and removing the dewatering equipment shall be at CONTRACTOR's expense.
- C. Refer to Section 31 2319, Dewatering, for additional requirements.

3.02 General

- A. The various construction operations shall be restricted to the existing right-of-way or the areas indicated on the Plans. If CONTRACTOR requires additional area, CONTRACTOR shall furnish the ENGINEER with written permission obtained from the property owner for any part of the operations he conducts outside of the right-of-way or limits indicated.

3.03 Existing Improvements

- A. CONTRACTOR shall expose existing sewers and structures to which the new Work is to be connected and notify ENGINEER of same. ENGINEER will verify the vertical and horizontal locations of the existing system and shall inform CONTRACTOR as to the necessary adjustments required to align the new Work with the existing system.

3.04 Existing Utilities

- A. When existing utilities are shown on the Plans, their locations are approximate only, as secured in the field investigation and/or from available public records. CONTRACTOR, prior to the start of construction, shall contact Miss Dig and the public agency or utility having jurisdiction to request the verification of all utilities within the construction area.
- B. When existing utility lines, structures or utility poles are encountered during the performance of the Work, CONTRACTOR, at his expense, shall perform his operations in such a manner that the service will be uninterrupted.
- C. CONTRACTOR shall expose all existing utility lines prior to any excavation operation, to determine any conflict with the proposed improvement. CONTRACTOR shall be responsible for any relocation required as a result of any conflict of existing utilities shown on the plans, with the proposed improvement.

- D. Should it become necessary to move any utility structure, line or pole shown on the Plans or otherwise found necessary to be moved, CONTRACTOR shall make all arrangements with OWNER of the utility for the moving. costs incurred for such moving shall be at CONTRACTOR's expense unless indicated otherwise. However, before disturbing a utility line, structure or pole, CONTRACTOR shall furnish ENGINEER with satisfactory evidence, in writing, that proper arrangements have been made with the owner of the utility.

3.05 Utility Poles

- A. CONTRACTOR shall be responsible for any removal or relocation required as a result of any conflict of existing utility poles (including street light poles, guy poles, telephone poles, etc.) with proposed improvements.
- B. CONTRACTOR shall make all arrangements for removing or relocating utility poles with the owner of the utility pole.
- C. Prior to disturbing any utility pole, CONTRACTOR shall provide ENGINEER with written evidence that proper arrangements have been made with the owner of the utility pole.
- D. When required by the Work, CONTRACTOR shall temporarily support poles in the vicinity of the Work at no additional cost to OWNER. Support shall be in accordance with and to the satisfaction of the utility company.

3.06 Existing Sewers, Tile, and Mains

- A. Existing sanitary sewers, storm sewers, drain tile, septic tank bed tiles, water mains or building services or leads, that are encountered during the performance of the Work that require relocation or are damaged, shall be restored with new materials equal in quality and type to the materials encountered.
- B. New material shall be installed as specified in the Contract Documents and per the requirements of the local agencies. Bedding and backfill material, unless otherwise specified, shall be an approved Class II granular material, compacted to 98% of its maximum unit weight.
- C. Seepage bed tile and water mains shall be replaced in accordance with the requirement of the agency having jurisdiction.
- D. Relocation or protection of existing sewers, tiles, tile field, water mains or building services and leads shall be at CONTRACTOR's expense, unless otherwise indicated in the Contract Documents.

3.07 Existing Structures

- A. Existing surface and subsurface structures may be shown on the Plans, in locations considered most probable from information secured in the field investigation or from available public records.
- B. Neither the correctness nor completeness of such information is guaranteed or implied.
- C. Structures shall be protected, preserved or restored by CONTRACTOR, to the satisfaction of the structure owner, at no additional cost to the Project.

3.08 Existing Buildings

- A. Existing buildings or structures may be encountered throughout the Project within limits of the presently established right-of-way or easement. Good construction methods and procedures shall be employed by CONTRACTOR, at his expense, to protect the structures.
- B. When it becomes necessary for CONTRACTOR to move one of these buildings or structures in order to proceed with construction, CONTRACTOR, at his expense, shall exercise all due care in moving the building or structure to prevent undue damage.
- C. Prior to moving an existing building or structure, CONTRACTOR shall furnish ENGINEER with satisfactory evidence, in writing, that proper arrangements have been made with the owner.
- D. Unless otherwise specified in the Contract Documents, the length of the move shall be maintained to a minimum which will allow for construction of the improvement.

3.09 Removal of Sewers and Culverts

- A. Unless otherwise specified in the Contract Documents, CONTRACTOR, at his expense, shall remove any abandoned culvert, pipe, sewer, structure or part of a structure which is to be replaced or rendered useless by the new construction.
- B. When a sewer or culvert is removed at a structure, CONTRACTOR shall install a masonry bulkhead in the structure.
- C. Removal of a culvert or sewer also includes the removal and disposal of end treatments or headwalls.

3.10 Removal of Structures

- A. Removal of existing structures shall consist of removing and salvaging the existing frame and cover. The ends of the existing pipe shall be plugged and braced. The complete structure shall be removed entirely and disposed of. The excavation shall be backfilled with sand and compacted to 98% of its maximum unit weight. Maximum unit weight shall be determined by ASTM D698, Method B.
- B. If a structure is to be removed from a system that is to remain in service, a bypass system, approved by ENGINEER, shall be installed and maintained by the CONTRACTOR, during the rebuilding period.

3.11 Abandoning Structures

- A. Structure shall be broken down to at least 30 inches (750 mm) below the subgrade.
- B. Pipes connected to the structure shall be plugged with a brick, masonry or concrete bulkhead approved by ENGINEER.
- C. Structure shall be backfilled with flowable fill to 1-foot (300 mm) above the pipes and the remainder of the structure backfilled with sand-cement mixture at a 10 to 1 ratio to subgrade elevation or to 1-foot (300 mm) below finished grade.

- D. The remainder of the excavation shall be backfilled with a granular material, compacted to 98% of its unit weight, and shall meet with the approval of ENGINEER.
- E. Maximum unit weight shall be determined by ASTM D698, Method B.

3.12 Salvaged Material

- A. Salvaged materials shall become the property of CONTRACTOR unless otherwise specified in the Contract Documents, and shall be disposed of by CONTRACTOR, at his expense.

3.13 Crop Damage

- A. In areas where crops are encountered along the route of the construction, a written agreement shall be arrived at by CONTRACTOR and the crop owner as to the type and nature of the crop concerned prior to any construction within the area.
- B. CONTRACTOR shall be responsible for making full reimbursement to the owner of the crop damage on the basis of the following procedure:
 - 1. Area of the crop damage shall be determined by measurements taken by ENGINEER, and this area shall include those portions of the crop which may extend into the public right-of-way.
 - 2. Average yield of the crop shall be established by the County Office of the U.S. Agricultural Extension Service.
 - 3. Cost of the crop shall be determined by using the prevailing price at the time of harvest as furnished by the U.S. Agricultural Extension Service.
- C. CONTRACTOR shall furnish ENGINEER with satisfactory evidence that payment for crop damage was made, prior to receiving final payment on the Project.

3.14 Trees

- A. Trees excepting those specified on the Plans to be removed, shall be effectively protected by CONTRACTOR during his construction operations.
 - 1. If in the opinion of ENGINEER, the methods of protection employed by CONTRACTOR are not adequate, CONTRACTOR shall carry on his operation by tunneling, or by other approved means, which will not cause undue damage to the trees.
- B. The requirements for tree tunneling are as follows:
 - 1. Depth of Cover:
 - a. Tunnels shall be placed at a minimum depth of 30 inches (0.75 m), measured from the ground surface to the top of the tunnel.
 - 2. Length of Tunnel:

- a. Tunnel length in feet (meters) shall be in direct proportion to diameter of tree in inches (millimeters) for trees eight (8) inches (200 mm) or larger in diameter. One (1) foot of tunnel shall be constructed for each inch of tree diameter whenever the trench or any portion thereof approaches the tree trunk a distance in feet equal to one-half the tree diameter in inches.
 - b. Example: A tree 12 inches in diameter shall require a 12-foot tunnel whenever the trench or any portion thereof approaches within six (6) feet of said tree.
- 3. Measurements:
 - a. Trees under 8 inches in diameter will require the same length of tunnel as 8-inch trees. Measurements of tree diameters shall be taken four (4) feet above the ground surface.
- C. Where the Plans indicate areas allowing the cutting of minor trees, care should be used to keep damage to adjacent trees to an absolute minimum. Where these areas are specifically indicated on the Plan, they are to be cleared and all trunks and branches shall be disposed of by CONTRACTOR. Debris shall not be bulldozed on to adjacent private property.
- D. Trees damaged by the construction operation shall be repaired so not to inhibit growth or replaced at the expense of CONTRACTOR. Repair or replacement shall be contingent upon agreement between the damaged tree owner and CONTRACTOR. In any event, limbs, branches and roots damaged by CONTRACTOR shall be properly pruned to the satisfaction of ENGINEER.
- E. Costs incurred for protection of trees, including tunneling, repair and replacement, if necessary, shall be at CONTRACTOR's expense.

3.15 Remove and Replace Tree

- A. Tree removal and replacement may be accomplished in two ways:
 - 1. CONTRACTOR may completely remove and dispose of the existing trees, and after the new improvement has been completed, tested, accepted and rough grading has been completed, CONTRACTOR shall plant new trees, in approximately the same location as the existing trees, of size and species per the following (existing trees to be replaced with like specie):
 - a. "Acer Rubrum" October Glory Red Maple, 2 ½-inch B&B (min)
 - b. "Malus Centzam" Centzam Crabapple, 2-inch B&B (min)
 - c. "Crataegus Phaenaopyrum" Washington Hawthorn, 8-foot B&B (min)
 - d. "Pinus Nigra" Austrian Pine, 6-foot B&B (min)
 - e. "Picea Pungens" Colorado Spruce, 5-foot B&B (min)
 - f. "Quercus Rubra" Red Oak, 2 ½-inch B&B (min)
 - g. "Pyrus Calleryana" Redspire Pear, 2-inch B&B (min)
 - 2. CONTRACTOR may remove and preserve the existing trees.
 - a. The trees shall be properly cared for and maintained in a healthy condition.

- b. After the new improvement has been installed, tested, accepted and rough grading completed, the trees shall be replanted in approximately the same location. Any trees damaged, destroyed or which die, shall be replaced at no additional cost.
- B. Trees, whether replanted or planted new, shall be guaranteed for a period of two years from the date of substantial completion.

3.16 Removing Pavement

- A. Removal of concrete and bituminous pavement as called for on the Plans shall consist of removing and disposing of pavement and shall include base courses, surface courses, integral and separate curbs, integral and separate curb and gutters, sidewalks and end headers.
- B. Pavement shall be removed to an existing joint or cut parallel to the existing pavement joints.
- C. Cutting shall be accomplished by using a power-driven concrete saw approved by ENGINEER. Depth of the saw cut shall be a minimum of 6-inches, to ensure that the removal of the old pavement will not disturb or damage the section of pavement remaining in place.
- D. Residual concrete pavement shall not be less than five feet measured transversely, nor less than 6 feet longitudinally measured from a joint.
- E. In removing a concrete base course, where part of the existing bituminous surface is to remain in place, the bituminous surface shall be cut the full depth by the use of a power-driven saw, approved by ENGINEER along a line parallel to and at least one foot from either side of the base course removal.
- F. Old pavement with a concrete cap shall be considered as only one (1) pavement, whether or not there is a separation layer of earth, aggregate, or bituminous material between the old material and the concrete cap.
 - 1. Removal of Curb for Curb Drop:
 - a. Where curb is to be removed for a curb drop, the operation shall be performed by saw cutting or by cold milling, approved by ENGINEER, so as to leave a neat surface with a maximum 1-inch lip, without damage to the underlying pavement.
 - 2. Removal of Curb and Gutter:
 - a. Where curb and gutter are to be removed, the operation shall be performed by saw cutting. The limits of the removal shall be as called for on the Plans, or as approved by ENGINEER. However, in no case shall the width of removal be less than 18 inches for sections with rolled or straight curb or less than 24 inches for mountable curbs.
- G. If during the pavement removal operation any concrete or bituminous pavement or surfacing is damaged beyond the removal limits designated, the damaged pavement or surfacing shall be removed and replaced at CONTRACTOR's expense.

- H. Earth which may be removed during the pavement removal operation shall be replaced by backfilling to the proposed subgrade with a suitable material, approved by ENGINEER, at CONTRACTOR's expense.

3.17 Guardrail

- A. Beam guardrail shall be relocated or shall be removed as specified on the Plans or as determined by ENGINEER. If any of the existing material is damaged or destroyed, CONTRACTOR shall replace the material at his expense.
- B. Where guardrail is encountered during construction, and its removal was not called for on the Plans, it shall be replaced or restored, at CONTRACTOR's expense, to a condition comparable to that prior to construction.
- C. After the guardrail removal or relocation operations are complete, all surplus material shall be removed and disposed of by CONTRACTOR, at his expense, unless otherwise called for in the Contract Documents.
- D. Any holes or voids resulting from the guardrail removal operation shall be backfilled with a Class II granular material, approved by ENGINEER.

3.18 Fences

- A. Fences shall be removed and replaced or shall be removed as indicated on the Plans. If any of the existing material is damaged or destroyed, CONTRACTOR shall replace the material at his expense.
- B. Where fencing is encountered during construction, and its removal was not called for on the Plans, it shall be replaced or restored, at CONTRACTOR's expense, to a condition comparable to that prior to construction.
- C. After the fence removal or relocation operations are complete, all surplus material shall be removed and disposed of by CONTRACTOR, at his expense, unless otherwise called for in the Contract Documents.
- D. Any holes or voids resulting from the fence removal operation shall be backfilled with a suitable material, approved by ENGINEER.
- E. Where fences are encountered that are being used to confine livestock or to provide security, the fence shall be immediately replaced following construction. During construction, CONTRACTOR, at his expense, shall provide, install and maintain a temporary fence, meeting the approval of ENGINEER.

3.19 Holes

- A. Earth removed during any phase of the excavation or removal operations, resulting in a hole or void, shall be replaced by backfilling to the proposed subgrade with a suitable granular material. Material shall be placed by the controlled density method or other effective means having the approval of ENGINEER and shall be compacted to 95% of maximum unit weight.
- B. Furnishing, placing and compacting of the backfill material shall be at CONTRACTOR's expense.

3.20 Restoration in Right-of-Way and Yard Areas

- A. Right-of-way and yard areas not paved or aggregate surfaced shall be restored in accordance with the type and location specified herein unless indicated otherwise on the Plans. Disturbed areas may be shaped by "Machine Grading" or another method approved by ENGINEER to achieve the cross section, line and grade shown on the Plans. Areas where slopes are 1 on 4 or flatter shall be restored with topsoil, seed and mulch. Slopes steeper than 1 on 4 shall be restored with sod.
- B. Excess material from the restoration operation shall be disposed of by CONTRACTOR at his expense.
- C. Disturbed areas shall be graded to receive either topsoil and seed or topsoil and sod. Topsoil, seed, sod, fertilizer and mulch shall conform to the requirements specified on the Plans and in Section 32 9219, Seeding, or Section 32 9223, Sodding.
- D. CONTRACTOR, at his expense, shall furnish, place, and compact any additional fill, meeting the approval of ENGINEER, needed to restore the disturbed areas to the cross sections called for on the Plans or as determined by ENGINEER.

3.21 Restoration of Aggregate Surfaces

- A. Shoulders:
 - 1. Shoulder shall be regarded as the area between the edge of pavement and the ditch, or the area within 10 feet of the pavement, whichever is the lesser.
 - 2. Backfilling of trenches in the shoulder area shall be carried to within 5 inches of the existing surface as specified under Trench "A" or Trench "B." The remaining depth shall be backfilled with a minimum of 5 inches of compacted 22A or 23A aggregate with calcium chloride applied, at the rate of 6 pounds per Ton of aggregate.
 - 3. CONTRACTOR, at his expense, shall furnish, place and compact all materials necessary to complete the backfilling and restoration operation within the shoulder area.
- B. Driveways and Parking Areas:
 - 1. Aggregate driveway areas shall be regarded as the area from the right-of-way line to the edge of the traveled roadway and shall include the shoulder area.
 - 2. Backfilling of trenches crossing aggregate surfaced driveways and parking areas shall be carried to the bottom of the proposed base course as specified under Trench "B". The remaining depth shall be backfilled with a minimum of 6 inches of compacted 22A or 23A aggregate, with calcium chloride applied at the rate of 6 pounds per Ton of aggregate.
 - 3. Aggregate surfaced areas beyond the limits of the actual excavation which are disturbed, as determined by ENGINEER, by such operations as temporary storage of materials or passage of equipment, shall be resurfaced, at CONTRACTOR's expense.

- a. Upper 3 inches of disturbed areas shall be removed as necessary to allow the final elevation of the resurfacing course to be at the elevation of the drive or parking area which existed prior to excavation.
 - b. Disturbed area shall be resurfaced with a minimum of 3 inches of compacted 22A or 23A aggregate, with calcium chloride applied at the rate of 6 pounds per Ton of aggregate
 - 4. CONTRACTOR, at his expense, shall furnish, place, and compact all materials necessary to complete the backfilling and restoration operations within the driveway and parking area.
- C. Roads and Streets:
- 1. Backfilling of trenches crossing aggregate surfaced roads or streets shall be carried to within 12 inches of the existing surface as specified under Trench "B." The remaining depth shall be backfilled with two 6-inch layers of compacted 22A or 23A aggregate, with calcium chloride applied at the rate of 6 pounds per Ton of aggregate.
 - 2. CONTRACTOR, at his expense, shall furnish, place, and compact all materials necessary to complete the backfilling and restoration operations within the roadway or street area.
 - 3. Also, any settlement of the aggregate surface shall be restored by placing additional aggregate, up to the original grade, and shall be done at the CONTRACTOR's expense.
- D. Compaction:
- 1. Compaction of all aggregate shall be performed by a pneumatic-tired roller or a vibratory compactor until the material forms a stable surface.

3.22 Restoration of Paved Surfaces

- A. CONTRACTOR, at his expense, shall provide the materials necessary to complete the backfilling and restoration operations, which shall include furnishing, compacting, forming, placing, rolling, floating, jointing, finishing, curing and providing protection against elements.
- B. Restoration of any roadways that are partially damaged shall include a minimum replacement of one (1), full width lane of roadway. The length of replacement shall be at least equal to the width.
- C. Concrete:
 - 1. Backfilling of trenches crossing concrete driveways, sidewalks, roads, streets or parking areas shall be carried to the bottom of the proposed pavement as specified under Trench "B"
 - 2. Unless otherwise specified on the Plans or as determined by ENGINEER, the concrete removed shall be replaced with 3,500 psi concrete of the thickness removed and shall include reinforcing equal to the existing, if the existing pavement was reinforced.

- a. The construction of concrete pavements shall be in accordance with Section 32 1313, Concrete Paving.
 3. Restoration of sidewalks shall also include the construction of sidewalk ramps at the intersection of the curb and shall conform to the current rules and regulations of Act 8, Michigan PA 1973, as amended and to Section 32 1315, Sidewalks and Driveways, and unless otherwise indicated in the Proposal, shall be considered incidental to the Project.
- D. Bituminous:
1. Backfilling of trenches crossing bituminous driveways, sidewalks, roads, streets or parking areas shall be carried to the bottom of the base course as specified under Trench "B."
 2. Bituminous pavement or bituminous surface course with an aggregate base shall be replaced in accordance with Section 32 1216, Bituminous Paving.
 3. Bituminous surfaced areas beyond the limits of the actual excavation which are disturbed by such operations, as temporary storage of materials or passage of equipment, shall be resurfaced with an approved bituminous mixture the same thickness as removed, but in no case less than 2 inches in thickness. Replacement material shall extend to smooth-cut edges, shall be uniform in direction and shall be at an elevation which provides a uniform surface between the undisturbed abutting surfaces.
 4. Restoration of any bituminous chip seal shoulders that are damaged or partially damaged, as determined by ENGINEER, shall include complete replacement full width and length (extending a minimum of 25 linear feet beyond the damaged area both ways). Existing bituminous chip seal shoulders shall be brought to proper grade with compacted 22A or 23A aggregate and resurfaced with a double chip seal per Section 32 1216, Bituminous Paving.

3.23 Soil Erosion and Sedimentation Control

- A. CONTRACTOR shall comply with the requirements of Section 01 5713, Temporary Erosion and Sediment Control. Prior to commencing any type of earthwork, CONTRACTOR shall obtain a Soil Erosion and Sedimentation Control permit from the local enforcing Agency.
- B. CONTRACTOR, at his expense, shall obtain all approvals, secure all permits and post all bonds and deposits required to comply with the Soil Erosion and Sedimentation Control Act, Part 91 of PA 451 of 1994, as amended, and those of the enforcing agency.
- C. CONTRACTOR shall provide ENGINEER with a copy of the soil erosion permit issued by the local enforcing agency for the Project, prior to commencing any type of earthwork on the Project.

3.24 Excess Excavation

- A. Excess excavation shall be defined as all surplus earth material realized from the construction that is free of brush, roots, stumps, broken concrete, pipe, debris, and other extraneous material.

- B. CONTRACTOR, when requested by OWNER, shall transport all excess excavation to a site(s) designated by OWNER.
 - 1. Excess excavation shall be graded by CONTRACTOR to provide positive surface drainage of the site(s).
 - 2. Grading shall be done such that adjacent properties are not damaged or affected. The grading shall include removal of all surface irregularities to provide a smooth surface (\pm 0.25 foot).
- C. When the excess excavation has not been requested by the OWNER, CONTRACTOR shall remove and properly dispose of the material at no additional cost to OWNER.
- D. Proper disposal of all excess excavation, including transportation, grading, and protection of adjacent properties shall be considered as a final cleanup item. No additional payment will be made for this item.
- E. Brush, roots, stumps, broken concrete, pipe, debris, and other extraneous material from the construction shall become the property of CONTRACTOR, and shall be disposed of per all applicable Laws, rules or regulations. Removal and disposal of this material shall be considered as part of final cleanup. No additional payment will be made for this item.
- F. OWNER approval of the final site(s) condition in writing will be required prior to final payment authorization.

End of Section

Section 01 8933

Temporary Bypass Pumping

Part 1 General

1.01 Work Summary

- A. Section Includes: Complete system responsibility for temporary bypass pumping of the mixed liquor pumping from the aeration tanks to Final Clarifier No.'s 1 & 2 during construction of the Work as specified in this and related Sections, including design, labor, materials, mobilization, spill control and containment, all equipment necessary, including mobilization, demobilization, and site restoration at completion of operations. Bypass pumping supplier shall also be responsible for commissioning, performance and capacity verification, operation and system maintenance for as long as necessary until permanent facilities are completed and normal flow can be resumed.

1.02 System Description

- A. Flow control during construction shall be provided to meet the minimum flow rates as listed on Schedule and shall perform reliably and continuously to provide uninterrupted sanitary service during the execution of the Work. If CONTRACTOR determines that the temporary electric power provision shown on the Drawings is insufficient for the proposed bypass pumps, and the required modifications will affect the Contract amount, it shall be brought to ENGINEERS attention prior to Bid date. Minor modifications regarding temporary power supply may be made during submittals.
- B. Provide temporary flow control facilities that can be installed, operated, maintained, and removed without damage to existing structures. Under no circumstances shall sewage or solids be deposited onto the ground surface, streets, or into ditches, catch basins or storm drains, or natural drainage ways. In the event that the sewage backup occurs and enters dwellings or other structures, CONTRACTOR shall be responsible for clean-up, repair, property damage costs, fines imposed by jurisdictional authorities, and all claims arising therefrom. All spills shall be contained and returned to the sewer system unless the pumped liquid is approved by the authorities having proper jurisdiction to be discharged to surface waters of the State.

1.03 Submittals

- A. Flow Control Plan: Submit in accordance with Section 01 3300, Submittal Procedures, covering the items included under this Section. Submittals shall include:
 - 1. General arrangement of system with approximate dimension.
 - 2. Pump data sheets indicating type of pumps to be used and motor horsepower.
 - 3. Emergency back-up plan.
 - 4. List of backup pump(s), piping, and appurtenances that are ready to deploy immediately.
 - 5. Piping materials.
 - 6. System control and alarm data.
 - 7. Data for accessories to be supplied.

- B. Emergency Personnel: Provide at least 2 people who can be contacted 24 hours per day by phone to address emergencies, along with their names, phone numbers, and working schedules. List shall be updated if there are any substitutions at least 2 days in advance. These people shall be connected to the control system automatic dialer (or equivalent).

1.04 Performance Responsibility

- A. Flow control service provider shall be solely responsible for the design, including all materials of construction to meet these performance measures and operating conditions/environment. The listed parameters are minimum requirements and shall not be construed as ENGINEER assuming design responsibility or liability.

1.05 Quality Assurance

- A. Qualifications: Firms regularly engaged in bypass pumping systems, of types and sizes required, and whose systems have been used with successful results in similar service for not less than 5 years.

1.06 Sequencing

- A. Refer to the Contract Drawings for sequence of construction requirements.

Part 2 Products

2.01 Manufacturers

- A. Subject to compliance with specified requirements, the temporary flow control bypass pumping companies offering services which may be used as part of the Work include:
 - 1. Mersino Dewatering, Inc.
 - 2. Thompson Pump Midwest.
 - 3. ENGINEER-approved equal.

2.02 Components

- A. Pumps: Pumping units shall, in general be designed to handle the services indicated. Raw sewage pumps shall be capable of passing a 3-inch solid.
- B. Flow Control System Power Supply: CONTRACTOR shall install the necessary cables and breakers to obtain power from the power supply given in the schedule. Provide transformers as needed.
- C. System Electrical Controls: Control panel(s) equipped with necessary fused-switch combination starters, control transformer, Start-Stop controls, cycle controls, variable speed drive controls, and alarm systems. Provide all necessary relays, timers, interlocks, and control devices. If mounted outdoors enclosure shall be minimum NEMA.4.
 - 1. Level controls such as float switches, pressure transducers, or level sensors along with the necessary wiring back to the temporary control panel shall be provided as required.
 - 2. In lieu of providing manpower to continuously monitor the pumping equipment on a 24-hour basis a dialer may be provided that will alert CONTRACTOR when an alarm condition exists. CONTRACTOR shall make arrangements to obtain temporary phone service for dialer system or the dialer shall be connected to the plant operating system if shown.

3. Automatic switch over capabilities shall be provided to activate standby equipment.
 4. Alarm when stand by equipment is operating.
 5. Alarm when aeration tank effluent channel is outside of normal operating range.
 6. Alarm when there is a power outage.
 7. Alarm status indication consisting of alarm light, mounted in an easily visible location.
 8. If shown the temporary flow control system shall be wired into the Plant's electronic operation and control system.
 9. Provide temporary lighting available for 24-hour per day pumping operations to aid with reliable system operation, maintenance and safety of personal.
- D. Piping: Piping shall be maintained in a watertight condition. Any leaks shall be immediately repaired. Provide piping designed to withstand minimum 1.5 times the maximum system pressure.

Part 3 Execution

3.01 Construction

- A. Unless otherwise approved in the flow control plan, there shall be minimum one responsible person or combination of responsible people available 24 hours per day to respond immediately and arrive on site within 15 minute to monitor and maintain the bypass and implement the emergency procedures if necessary.
- B. CONTRACTOR shall immediately notify OWNER and ENGINEER if a sanitary sewer overflow occurs and take the necessary action to clean up and disinfect the spillage to the satisfaction of the OWNER or other governmental agencies. If sewage is spilled onto public or private property, CONTRACTOR shall wash down, clean up, and disinfect the spillage to the satisfaction of the property owner.
- C. In the event that sewage backup occurs and enters dwellings or other structures, CONTRACTOR shall be responsible for clean up, repair, property damage costs, fines imposed by jurisdictional authorities, and all claims arising therefrom. All spills shall be contained and returned to the sewer system.
- D. When temporary flow control operations are complete, all bypass piping shall be drained into the wastewater system prior to disassembly and all equipment and materials removed from the site.

3.02 Field Quality Control

- A. Site Performance Tests: After the equipment has been installed, performance tests shall be conducted to demonstrate the system is in good working order, the units have been properly installed, will operate satisfactorily, and meet the specified conditions.

3.03 Temporary Flow Schedule

- A. General:

- | | | |
|----|-------------------------------------|---------------------|
| 1. | Total Bypass Capacity: | 40 MGD |
| 2. | Minimum No. Electric Pumping Units: | 2 |
| 3. | Minimum No. Standby Pumping Units: | 1 |
| 4. | Flow Stream to Be Bypassed: | Influent |
| 5. | Pump From: | Influent Structure* |
| 6. | Pump To: | Grit B * |
- B. Refer to Contract Drawings for more information regarding potential range of incoming flows to the Influent Structure.
- C. Pump discharge pipe shall run from the Influent Structure to Battery B Grit and be split among the two tanks (i.e., 20 MGD to each tank). The discharge of the pipe shall be fitted with an increaser/tee fitting to discharge the flow at a slower velocity in a horizontally tangential direction into each of the tanks.
- D. Remarks:
1. Provide VFD's on pumps with automatic turndown capability to lower pumping rate as level decreases in effluent chamber. Turndown to 4 MGD per pump.
 2. Feed electrical from existing Phosphorus Building adjacent to the Influent Structure. Coordinate and field verify connection point with OWNER's staff.
 3. Maximum HP of pumps to be 75 HP to accommodate existing electrical system.
- E. OWNER to pay for electricity for pumps.

End of Section

Division 02
Existing Conditions

Section 02 4100 Demolition

Part 1 General

1.01 Section includes

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

1.02 Reference Standards

- A. 29 CFR 1926 - U.S. Occupational Safety and Health Standards.
- B. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations.
- C. NFPA 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities, current edition.

1.03 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.

1.04 Submittals

- A. Submit in accordance with Section 01 3300.
- B. 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.
- C. Health and Safety Plan (HASP). Submit a HASP for workers exposed to sewage sludge materials or other hazards as part of this work.
- D. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.05 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.

1.06 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. This project is in a municipal wastewater treatment plant. The work will involve contact with sewage sludge which contains pathogens and other bacteria which can affect human health. Proper care and protection for all workers coming in contact with these materials is the responsibility of CONTRACTOR. A Health and Safety Plan shall be prepared by CONTRACTOR for this purpose.
- C. 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 OWNER for ongoing operations of the treatment plant.
- D. 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 OWNER insofar as practicable. However, variations within a structure may occur prior to the start of demolition work.
- E. Promptly repair damage caused to adjacent facilities by demolition operation when directed by the ENGINEER at no cost to OWNER. Repairs shall be made to a condition at least equal to that which existed prior to construction.

1.07 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 CONTRACTOR's employees.
- B. 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, and rescue squads, shall be conspicuously posted at the site.

1.08 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 Products (Not Used)

Part 3 Execution

3.01 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 OWNER.
- C. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
 2. Protect items from damage during transport and storage.
 3. 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.
- D. Protect existing structures and other elements that are not to be removed.
1. Provide bracing and shoring.
 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.
- E. Partial Removal of Paving, Concrete structures and Curbs: Neatly saw cut at right angle to surface.

3.02 Existing Utilities

- A. Coordinate work with utility companies; 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 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 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.
- 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.

3.03 Selective Demolition for Alterations

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as shown.
 - 2. Report discrepancies to Engineer before disturbing existing installation.
 - 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. Maintain a minimum temperature of 40 degrees Fahrenheit in all areas where are being used for plant operations or higher temperature 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 Process equipment, HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove existing systems and equipment as indicated.
1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
 2. 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 ready for service.
 3. Verify that abandoned services serve only abandoned facilities before removal.
 4. When a piece of equipment is shown to be removed, it shall be assumed that the power feed to that piece of equipment including conduit/wire/starter shall also be removed.
 5. Piping interconnecting pieces of equipment and/or associated with the system to be removed shall be removed even if not specifically shown to be removed on the drawings. Pipe supports associated with removed piping shall be removed.
 6. 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.
 7. Remove concrete equipment bases for equipment to be removed to the building foundation/floor.
 8. 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.
 9. 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.
 10. Conduits and wires shall be abandoned or removed where shown. Wires in abandoned conduits shall be removed and disposed of off-site as required. 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. 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 and masonry in small sections.

2. Wherever possible, sawcut materials to be removed. Where jackhammering or other destructive means are required, care shall be taken to protect existing remaining equipment/structures.
3. Remove structural framing members and lower to ground by means of hoists, derricks, or other suitable methods.
4. Remove structures to the lines and grades shown unless otherwise directed by 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 CONTRACTOR's expense and these excess removals shall be reconstructed to the satisfaction of ENGINEER with no additional compensation to CONTRACTOR.
5. 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.

3.04 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.

3.05 Disposal of Tank Contents

- A. CONTRACTOR shall remove and dispose of the contents of tanks, wells, etc. as required to perform the Work.
- B. Liquid in tanks may be returned to the treatment plant process stream with written approval of OWNER.
- C. Provide written certification to OWNER that disposal of tank contents is in accordance with applicable state and federal regulations.

3.06 Cleaning

- A. 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.

3.07 Salvage Schedule

- A. Existing Items to Be Removed and Salvaged:

1. No existing items will be salvaged to OWNER. CONTRACTOR retains ownership and responsibility for all items shown to be removed.

End of Section

Division 03
Concrete

Section 03 1100 Concrete Forming

Part 1 General

1.01 Scope of Work

- A. This Section includes formwork for cast-in-place concrete, complete with furnishing, preparation, installation, coating, protection, adjustment, removal and accessories.

1.02 Related Work Specified Elsewhere

- A. Section 03 1500: Concrete Accessories
- B. Section 03 2000: Concrete Reinforcing
- C. Section 03 3000: Cast-In-Place Concrete
- D. Section 31 2316: Structural Excavation and Backfill

1.03 Design Standards

- A. Formwork shall be designed for the loads, lateral pressure, and allowable stresses outlined in "Recommended Practice for Concrete Formwork" ACI 347 and for design considerations, wind loads, allowable stresses and other applicable requirements of the local building code. Design and construction of the formwork shall be the responsibility of CONTRACTOR.
- B. Formwork shall be true in every respect to produce hardened concrete to the required shape, size, grade and alignment as indicated on the Plan, and of sufficient strength, bracing and rigidity to maintain their position and shape under the loads and operations incidental to placing and curing the concrete, as well as other forces resulting from the movement of the forms.
- C. Forms shall be mortar-tight at the time concrete is placed in them and shall be so constructed that the surfaces of the finished concrete will be reasonably free from ridges, fins, offsets, or similar defects. A
- D. Adequate and suitable means for removing the forms without injury to the surfaces or edges of the finished concrete shall be provided.

1.04 Allowable Tolerances

- A. Formwork shall be constructed such that the hardened surfaces shall conform to the tolerance limits of ACI 347, except as modified below:
 - 1. Variation from plumb in lines and surfaces of piers, walls, or columns:
 - a. In any ten (10) feet (3 m) of length: 1/4 inch (5 mm)
 - b. Maximum for entire length: 1-inch (25 mm)
 - 2. Variation from the level or from the grades:
 - a. In any ten (10) feet (3 m) of length: 1/4 inch (5 mm)
 - b. Maximum for entire length: 3/4 inch (20 mm)
 - 3. Variation of distance between walls, columns and beams:
 - a. In any ten (10) feet (3 m) of distance: 1/4 inch (5 mm)
 - b. Maximum for entire distance: 1-inch (25 mm)

4. Variation of the linear lines from established position as indicated on the Plans:
 - a. In any 20 feet (6 m) of length: 1/2 inch (10 mm)
 - b. Maximum for entire length: 1-inch (25 mm)
5. Variation in sizes and locations of sleeves, floor openings, and wall openings:
 - a. Minus: 1/4 inch (5 mm)
 - b. Plus: 1/2 inch (10 mm)
6. Variation in cross-sectional dimensions of columns and beams and thickness of slabs and walls:
 - a. Minus: 1/4 inch (5 mm)
 - b. Plus: 1/2 inch (10 mm)
7. Variations of footing dimensions from plan dimensions:
 - a. Minus: 1/2 inch (10 mm)
 - b. Plus: 2 inches (50 mm)
8. Thickness \pm 5%, up to maximum of 1 inch (25 mm)

1.05 Reference Standards

- A. ACI - American Concrete Institute
- B. ASTM - ASTM International

1.06 Submittals

- A. Submit manufacturer's literature for form coating.
- B. Submit formwork layout plans, design data and procedures if requested by ENGINEER.

1.07 Storage and Handling

- A. Store and handle form coating to prevent contamination of coating in accordance with manufacturer's recommendations.

1.08 Sequencing

- A. Sequence installation of formwork with the Work of Section 03 2000, Concrete Reinforcing; Section 03 1500, Concrete Accessories; and Section 03 3000, Cast-In-Place Concrete.

Part 2 Products

2.01 Form Materials

- A. Use lumber that is straight, uniform width and thickness, free from knots, offsets, holes, dents, warpage and other surface defects.
- B. Use plywood product of standard psi, waterproof, resin-bonded, exterior-type Douglas Fir, face adjacent to concrete shall be Grade B or better.
- C. Metal forms to be smooth metal plate free of surface irregularities.

- D. Chamfer Strips: Use clear white pine, surface against concrete planed, 1-inch (25 mm) bevel width or cant strip.

2.02 Form Coating

- A. Use nonstaining form oil or other mineral oil which will neither discolor nor otherwise injuriously affect the concrete.

2.03 Form Ties

- A. Use permanently embedded body type with removable end cones on outer ends, permanently embedded portion 1-inch (25 mm) back from concrete face.

2.04 Forms - General

- A. Use forms that conform to ACI 347. Fabricate with facing materials that produce the specified tolerance requirements of Article 1.04 of this Section; produce true surfaces, sharp corners and true lines; and are free of offsets, ridges, bulging, waves and concave or convex areas.

2.05 Layout

- A. Use regular and uniform pattern; long dimension of panels vertical; joints horizontal, vertical and aligned; form ties uniformly spaced and aligned in horizontal and vertical rows.

Part 3 Execution

3.01 Preparation

- A. Forms shall not be reused if there is any evidence of surface wear and tear or defects which would impair the quality of the surface. Surfaces of forms and embedded materials shall be cleaned of any mortar from previous concreting and of all other foreign material or water before coating is placed in them.
- B. Forms shall be coated in accordance with manufacturer's recommendations before the form or reinforcement is placed in final position. Surplus coating on form surfaces, or any coating on reinforcing steel and construction joints shall be removed before placing concrete.

3.02 Installation of Forms

- A. Forms shall be sufficiently tight to prevent loss of mortar from the concrete, set true to the lines and elevations indicated on the Plans, tied and braced to remain true during and after concrete placement within tolerances of Article 1.04 of this Section. ENGINEER may at any time condemn any section or sections of forms found deficient in any respect, and such form shall be promptly removed and replaced.
- B. No wooden spreaders shall be allowed to remain in the concrete. No metal shall be within 1-inch (25 mm) of any surface.
- C. Place chamfer strips in forms to bevel all corners, edges, joints and other structural elements exposed to view, including use of dummy chamfer and false joints to provide neat and uniform appearance. Exposed corners and edges shall have 3/4" x 3/4" - 45° chamfers (20 mm x 20 mm x 45 degree), unless otherwise indicated on the Plan.
- D. Provide temporary openings at the base of wall forms and at the other points when necessary to facilitate cleaning and inspection immediately before depositing concrete.

- E. Secure in position wedges used for final alignment and items to be embedded in concrete.
- F. Forms for keyways shall be prepared in advance of pouring concrete. Keyway forms in slab edges and vertical wall joints shall be rigidly secured in place before the concrete is poured. Forms for keyways for horizontal joints in walls may be placed at the conclusion of the pour, but proper provision shall be made for obtaining and holding the full depth and form of the keyway.

3.03 Adjustment of Forms

- A. Positive means of adjustment should be provided to permit realignment or readjustment of shores if excessive settlement occurs.
- B. A pair of wedges may be used at the top or bottom of shores, but not at both ends, to facilitate vertical adjustment, to correct uneven settlements, or to facilitate dismantling of the formwork.
- C. Screw jacks for pipe shores or scaffold-type shoring may be used at both top and bottom so long as they are secured by the shore or scaffold leg against loosening or falling out, to avoid lateral deflections.
- D. During and after concreting, but before initial set of the concrete, the elevations, camber, and plumbness of formwork systems shall be checked, using telltale devices. Appropriate adjustments shall be promptly made where necessary. If, during construction, any weakness develops and the formwork shows any undue settlement or distortion, the Work shall be stopped, the affected construction removed if permanently damaged, and the formwork strengthened.

3.04 Removal of Forms

- A. Forms, wedges or shoring shall not be removed or disturbed until the concrete has attained sufficient strength to safely support superimposed dead, temporary construction, and live loads.
- B. When forms or shoring are removed, there shall be no excessive deflection or distortion of the concrete.
- C. Forms shall be removed in an orderly fashion; with care to avoid surface gouging, corner or edge breakage, or other damage or injury to the concrete surface or physical property; and without impact or shock, to permit the concrete to carry its share of the loads gradually and uniformly.
- D. Form removal shall not impair the safety and serviceability of the structure or concrete members.
- E. Forms and shoring in the formwork used to support the weight of concrete in beams, slabs, and other structural members shall remain in place a minimum of 14 days or until the concrete has reached a minimum of 75% of the design compressive strength. Cylinder strength shall be based on test specimens cured in the field, as described in ASTM C31, under conditions which are not more favorable than the most unfavorable conditions for the portions of the concrete which the test specimens represent and shall be determined in accordance with Section 03 3000, Cast-In-Place Concrete.

- F. Formwork for columns, walls and other vertical members shall remain in place a minimum of five (5) days or until the concrete has attained a minimum of 75% of its design strength. Where such formwork also supports the formwork of beams and slabs, the removal times of the latter shall govern. Face and edge forms shall be removed as soon as practicable and permitted by ENGINEER in order to facilitate effective repair of voids or broken corners before the surface has dried.
- G. Forms and shoring in the formwork shall not be removed without the approval of ENGINEER. Minimum in-place times are for ordinary conditions and represent cumulative number of days, not necessarily consecutive, after the concrete was placed, during which the temperature of the air surrounding the concrete is above 50 degrees Fahrenheit (10 degrees Celsius). The times may be increased or decreased as directed by ENGINEER, dependent on air temperatures, cement type, concrete additives or other conditions of the Work in accordance with ACI 347.

3.05 Reshoring

- A. When removing forms before structural members are strong enough to carry dead load and/or construction loads, reshores shall be installed to assure safe distribution of loading. Reshoring operations shall be planned in advance and shall be subject to ENGINEER's review.
- B. During reshoring, no construction loads shall be permitted on the new construction.
- C. Reshores shall be placed as soon as practicable after form removal, but in no case later than the end of the working day on which form removal occurs and shall remain in place until the concrete has acquired the required strength.

End of Section

Section 03 1500 Concrete Accessories

Part 1 General

1.01 Scope of Work

- A. This Section includes joint fillers, joint sealants, waterstops, and miscellaneous embedded items in concrete.

1.02 Related Work Specified Elsewhere

- A. Section 03 1100: Concrete Forming
- B. Section 03 2000: Concrete Reinforcing
- C. Section 03 3000: Cast-In-Place Concrete

1.03 Reference Standards

- A. ASTM - American Society for Testing Materials
- B. CRD - U.S. Army Corps of Engineers Handbook for Concrete and Cement Specifications

1.04 Submittals

- A. Submit certified manufacturer's affidavits for expansion joint filler, joint sealant and waterstops to verify compliance with the applicable Specifications.
- B. Submit a schedule of concrete pouring and indicate locations of proposed construction and expansion joints. This schedule is subject to approval of ENGINEER.

1.05 Environmental Requirements

- A. Environmental requirements relative to temperature for placing joint sealants are specified in article 3.04 of this Section.

1.06 Sequencing

- A. CONTRACTOR shall sequence installation of miscellaneous embedded items with the Work of Section 03 1100 Concrete Forming; Section 03 2000, Concrete Reinforcing; and Section 03 3000 Cast-In-Place Concrete.

Part 2 Products

2.01 Joint Filler

- A. Preformed Expansion Joint Filler for Concrete (Bituminous Type) ASTM D994.
- B. Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) ASTM D1751.
- C. Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Concrete ASTM D1752.

2.02 Joint Sealer

- A. Joint Sealants, Hot-Poured, For Concrete and Asphalt Pavements ASTM D6690 Type II.
- B. Joint Sealants, Hot-Poured, Elastomeric Type, for Portland Cement Concrete Pavements ASTM D3406.

2.03 Waterstops

- A. PVC waterstops shall conform to CRD-C572 polyvinyl chloride (PVC) or CRD-C513 styrene-butadiene rubber (SBR). Flat ribbed type shall be used in joints in walls and slabs where shown on the plans. Center bulb type shall be used in expansion joints.
- B. Bentonite waterstops shall be a compound of 75% high swelling sodium bentonite and 25% butyl rubber. Bentonite waterstops require an adhesive as recommended by the manufacturer to adhere the waterstop to the substrate.
- C. Hydrophilic rubber waterstop shall be a combination of chloroprene rubber and chloroprene rubber modified to impart hydrophilic properties. The waterstop shall have a delay coating to inhibit initial expansion due to moisture present in fresh concrete. Hydrophilic rubber waterstops require an adhesive as recommended by the manufacturer to adhere the waterstop to the substrate.

2.04 Concrete Anchors

- A. General:
 - 1. Select type and size to achieve required loading capacity using information provided by manufacturer. If required type is not indicated, select type appropriate to conditions and item being fastened.
 - 2. Maintain critical edge distance and spacing per manufacturer's recommendations for all anchors. Provide tamper proof hardware when called for on the plans.
- B. Adhesive Anchors:
 - 1. Combination capsule adhesive and insert system; chisel pointed threaded rod with hex nut/washer, reinforcing bar, or internally threaded insert, installed into pre-drilled anchor hole using rotary hammer drill, crushing glass capsule containing two part epoxy acrylate resin (vinyl ester) with quartz aggregate and hardening agent, forming adhesive mortar.
 - 2. Threaded rod: ASTM A 193 Grade B7, ASTM A 194 Grade 2H or ASTM A 563 Grade DH nuts, and ASTM F 436 washers; plated in accordance with ASTM B 633, SC1, with Type II yellow chromate treatment or Type 304 stainless steel when specified on the plans.
 - 3. Threaded Insert: Carbon steel tubular insert, internally threaded, plated in accordance with ASTM B 633, SC1.
- C. Wedge Type Anchors:
 - 1. One-piece body with expansion mechanism installed in pre-drilled hole using matching tolerance bit.

2. Carbon steel anchor body, washers, nuts and wedges, plated in accordance with ASTM B 633, SC1, Type III or Type 304 stainless steel anchor body, washers, nuts and wedges when so indicated on plans.

Part 3 Execution

3.01 Contractor's Verification

- A. Inspect the locations and surfaces to receive joint filler, joint sealer, waterstops, or miscellaneous embedded items and correct defects or conflicts which will affect the proper performance of the item to be placed.

3.02 Preparation

- A. Accessories to be embedded into concrete shall have contact surfaces free of dirt, curing compound, protrusions of hardened concrete or any other foreign material which would affect bond with concrete.
- B. Prime surfaces in accordance with manufacturer's recommendations.

3.03 Installation of Joint Fillers

- A. Details, including materials and methods of installation of joint fillers shall be as indicated on the Plans and as approved by ENGINEER.

3.04 Installation of Joint Sealants

- A. Joints shall not be sealed when the sealant, air or concrete temperature is less than 40°Fahrenheit (4°Celsius). Bond breaker and backup material shall be installed where required as indicated on the Plans or manufacturer's recommendations.

3.05 Installation of Waterstops

- A. Waterstops shall be of maximum practicable length to minimize joints.
- B. Waterstops shall be positioned as indicated on the Plans in a manner to permanently retain flexibility.
- C. Splice in length or at intersections shall be performed by heat sealing and in accordance with manufacturer's recommendations.
- D. Reform splices with a remolding iron with ribs or corrugations to match the pattern of the waterstop. When cooled and bent by hand in as sharp as an angle as possible, the splice shall show no sign of separation.
- E. Provide support and protection of the waterstops during the progress of the work. Any waterstop punctured or damaged shall be replaced or repaired at CONTRACTOR's expense. Concrete shall be thoroughly consolidated in the vicinity of the waterstop. Suitable guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstops from damage when concrete placement has been discontinued.

3.06 Concrete Anchors

- A. Do not begin installation until substrates have been properly prepared. Do not proceed with installation if substrate preparation is unsatisfactory.

- B. Clean surfaces thoroughly prior to installation. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Install in accordance with manufacturer's instructions and recommendations and as required by applicable code. Anchor applied items neatly, with item mounted plumb and level unless otherwise indicated.
- D. ENGINEER reserves the right to require the anchor manufacturer's representative to demonstrate proper installation procedures for post-installed anchors and to observe CONTRACTOR's installation procedures, at no extra cost to OWNER. ENGINEER reserves the right to require pullout or shear tests to determine adequacy of anchors, at no extra cost to OWNER.

3.07 Miscellaneous Embedded Items

- A. All sleeves, inserts, anchor bolts, and other embedded items required for adjoining Work or for its support shall be placed prior to concreting.
- B. Embedded items shall be positioned accurately and supported against displacement. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

End of Section

Section 03 2000 Concrete Reinforcing

Part 1 General

1.01 Scope of Work

- A. This Section includes the furnishing, fabrication, placement and care of material used as concrete reinforcement.

1.02 Related Work Specified Elsewhere

- A. Section 03 1100: Concrete Forming:
- B. Section 03 1500: Concrete Accessories
- C. Section 03 3000: Cast-In-Place Concrete

1.03 Reference Specifications

- A. Latest or current ACI Standards and Code Requirements for "Concrete and Reinforced Concrete" shall govern all concrete Work except where otherwise specified herein. Copies of standards can be obtained from the American Concrete Institute.

1.04 Testing Agency

- A. Testing agencies shall meet the requirements of Recommended Practice for Inspection and Testing Agencies for Concrete, Steel and Bituminous Materials as Used in Construction, ASTM E329.

1.05 Allowable Tolerances

- A. Fabrication:
 - 1. Sheared length: ± 1 -inch (25 mm).
 - 2. Depth of truss bars: +0, -1/2 inch (+0, -10 mm).
 - 3. Stirrups, ties, and spirals: $\pm 1/2$ inch (± 10 mm)
 - 4. All other bends: ± 1 -inch (± 25 mm).
- B. Placement:
 - 1. Concrete cover to form surfaces: $\pm 1/4$ inch (± 5 mm).
 - 2. Minimum spacing between bars: -1/4 inch (-5 mm).
 - 3. Top bars in slabs and beams:
 - a. Members eight (8) inches (200 mm) deep or less: $\pm 1/4$ inch (5 mm).
 - b. Members more than eight (8) inches (200 mm) but not over two (2) feet (600 mm) deep: $\pm 1/2$ inch (± 10 mm).
 - c. Members more than two (2) feet (600 mm) deep: ± 1 -inch (± 25 mm).
 - 4. Crosswise of members: Spaced evenly within two (2) inches (50 mm) of stated separation.
 - 5. Lengthwise of members: ± 2 inches (± 50 mm).

6. Maximum bar movement to avoid interference with other reinforcing steel, conduits, or embedded items: 1-bar diameter, with approval from ENGINEER.

1.06 Source Quality Control

- A. Reinforcing steel shall be subject to inspection at the source of supply, fabricator, or after delivery to the Project Site at the discretion of ENGINEER.
- B. CONTRACTOR may be required to furnish additional test of reinforcing steel for each 100 tons (90 metric ton) or fraction thereof. Testing for bend, pull, elongation and weight to assure compliance with Specifications shall be in accordance with ASTM A370.

1.07 Reference Standards

- A. ACI - American Concrete Institute
- B. ASTM - ASTM International
- C. CRSI - Concrete Reinforcing Steel Institute

1.08 Submittals

- A. CONTRACTOR shall submit Shop Drawings indicating the size and dimensions for fabrication and placing of reinforcing steel, including bar schedules, stirrup spacing, and diameter of bend bars. Bar supports type and grade shall be indicated.
- B. CONTRACTOR shall submit test certificates of the manufacturer's laboratory, identifying chemical and physical analysis of each load of reinforcing steel delivered.
- C. CONTRACTOR shall submit test certificates of a qualified independent testing agency evaluation of the mechanical splice devices to assure compliance with ACI 318.

1.09 Delivery, Storage, and Handling

- A. Deliver reinforcement to Project site in bundles tagged and marked in accordance with "Manual of Standard Practice" of the CRSI.
- B. Reinforcing steel shall be stored above ground on platforms or other supports, in an orderly manner to facilitate inspection and checking, and be protected from physical injuries or contamination.

1.10 Sequencing

- A. CONTRACTOR shall coordinate placement of the reinforcing in a manner which will not prevent the proper and timely completion of dependent construction phases.

Part 2 Products

2.01 Reinforcing Bars

- A. Reinforcement shall be of the grade and type as specified herein unless otherwise indicated on the Plans or Shop Drawing.
- B. Bars:
 1. Deformed and Plain Billet-Steel Bars: ASTM A615, Grade 60.
 2. Rail-Steel Deformed and Plain Bars: ASTM A616-96a, Grade 60.

3. Axle-Steel Deformed and Plain Bars: ASTM A617-96a, Grade 60.
4. Low Alloy Steel Deformed Bars: ASTM A706.

C. Mats:

1. Fabricated steel bar or rod mats of the clipped type shall conform to ASTM A184.

2.02 Welded Wire Fabric

A. Welded wire fabric shall be in flat mats only.

B. Plain:

1. Conform to ASTM A185, 6 x 6 – w2.9 x w2.9 unless otherwise indicated on the Plans.

C. Deformed:

1. Conform to ASTM A496, 6 x 6 – w2.9 x w2.9 unless otherwise indicated on the Plans.

2.03 Tie Wire

A. Plain:

1. Conform to Cold Drawn Steel Wire for Concrete Reinforcement, ASTM A82, 16-gage minimum size.

B. Deformed:

1. Conform to Deformed Steel Wire for Concrete Reinforcement, ASTM A496, size D-4 minimum.

2.04 Bar Supports

A. Metal bar supports shall be fabricated from cold-drawn steel wire in accordance with current CRSI Standards.

B. Stainless steel supports shall be of Type 1, with stainless steel wire conforming to ASTM A493 attached to the tips of the support so the nonstainless wire will lie no closer than 1/4 inch (5 mm) from the form surface.

C. Plastic coated supports shall be of Type 1, with plastic coating of polyethylene conforming to ASTM D1248 on the legs and tips.

D. Precast concrete brick supports shall conform to ASTM C55, Type 1, Grade N.

2.05 Fabrication

A. Bars shall be bent cold to the shapes and dimensions as indicated on the Plans, or as required by the current "Manual of Standard Practice" of the CRSI.

B. Steel shall not be bent or straightened in a manner that will injure the material. Bars with kinks or improper bends shall not be used.

- C. The diameter of bend measured on the inside of the bar for standard hooks, other than stirrups and tie hooks, shall not be less than the values of the following table.

Minimum Diameters of Bend	
Bar Size	Minimum Diameter
#3 through #8 (#10M - #25M)	6 bar diameters
#9, #10, and #11 (#29M - #36M)	8 bar diameters
#14 and #18 (#43M - #57M)	10 bar diameters

- D. Bends for stirrups and ties with number 5 (#16M) bar and smaller shall not be less than four bar diameters. For bars larger than No. 5 (#16M), shall be according to the "Minimum Diameter of Bend" table above.
- E. Bends for stirrups and ties for welded wire fabric shall not be less than 4-bar diameters for deformed wire larger than D-6 and 2-bar diameters for all other wires. Bends with inside diameter of less than 8-bar diameters shall not be less than 4-bar diameters from nearest welded intersection.

Part 3 Execution

3.01 Contractor's Verification

- A. CONTRACTOR shall examine the areas in which the reinforcing steel is to be placed to assure proper lines and levels.

3.02 Preparation

- A. Remove dirt, grease, oil, loose mill scale, excessive rust, and foreign matter that will reduce bond with concrete or splicing method.
- B. The ends of bars to be butt spliced shall be cut square and smooth.

3.03 Installation - General

- A. Reinforcing shall be placed as indicated on the approved Shop Drawings, within allowable tolerances. Bar supports, as indicated on approved Shop Drawings, or in Specifications, shall be used for proper separation and support of reinforcing steel.

3.04 Minimum Spacing

- A. Unless otherwise indicated on the Plans, the minimum spacing of bars shall be the following:
- B. Footings and other principal structural members in which the concrete is deposited against the ground shall have 3 inches (75 mm) of concrete between the bar and the ground contact surface.
- C. Concrete surfaces which, after removal of the forms, are to be exposed to the weather or in contact with the ground or liquids, shall be protected with 2 inches (50 mm) of concrete.
- D. The concrete protective covering for any reinforcement at surfaces not exposed directly to the ground, liquids or weather shall be 3/4 inch (20 mm) for slabs and walls and 1-1/2 inches (40 mm) for beams and girders.

- E. Column spirals or ties shall be protected everywhere by a covering of concrete cast monolithically with the core and shall be at least 1-1/2 inches (40 mm).
- F. Concrete protection for reinforcement shall in all cases be at least equal to the diameter of bars, except for concrete slabs as noted above.
- G. The minimum center to center distance between parallel bars shall be 2-1/2 times the diameter of the bars. In no case shall the clear spacing between bars be less than one inch (25 mm) nor less than 1-1/3 times the maximum size of the coarse aggregate. The maximum center to center distance in parallel bars shall be 18 inches (450 mm). Where reinforcement in beams and girders is placed in two (2) or more layers, the clear distance between layers shall be not less than 1-inch (25 mm), and the bars in the upper layers shall be placed directly above those in the bottom layer.
- H. Welded wire fabric designated as load-carrying reinforcement shall be overlapped wherever successive mats are continuous in such a way that the overlap measured between outermost cross wires of each fabric sheet is not less than the spacing of the cross wires plus 2 inches (50 mm). It shall be supported as required for reinforcing bars.

3.05 Splicing

- A. Splices shall be avoided at points of maximum stress. Splicing of bars shall be in accordance with ACI 318.
- B. Splicing of bars shall be done by overlapping in accordance with ACI Detailing Manual SP-66, and securely laced with wire unless indicated otherwise on the Plans or approved Shop Drawing.
- C. Lap adjoining wire mesh by no less than one (1) full mesh and lace securely with wire. Offset end laps in adjacent widths to prevent continuous splice.
- D. Welded wire fabric reinforcement shall be overlapped wherever successive mats are continuous in such a way that the overlap measured between outermost cross wires of each fabric sheet is not less than one full mesh spacing plus 2 inches (50 mm). The fabric shall extend across supporting beams and walls and to within 4 inches (100 mm) of concrete edges. It may extend through contraction joints where alternate wires are field cut. It shall be adequately supported during placing of concrete to insure its proper position in the slab either by the methods of Article 3.06 of this Section or by laying the fabric on a layer of the fresh concrete of the correct depth before placing the upper layer of the slab.
- E. Vertical bars in columns shall be offset at least 1-bar diameter at lapped splices. To insure proper placement, templates shall be furnished for all column dowels.
- F. Bars of size 14, 18 or larger (#43M #57M or larger), where size 11 (#36M) bars are butt spliced to larger sizes and/or when approved by the ENGINEER shall be welded in accordance with ACI 301 by full penetration butt welds. Adequate jigs and clamps or other devices shall be provided by the CONTRACTOR to support, align and hold the longitudinal centerline of the bars in a straight line.
- G. Bars larger than size eleven (#36M) may be butt spliced by mechanical devices approved by ENGINEER, in accordance with ACI 318. Splices shall be made using manufacturer's standard jigs, clamps, ignition devices and other required accessories to support, align and hold the longitudinal centerline of the bars in a straight line.

3.06 Securing Reinforcement

- A. Reinforcement shall be securely laced with wire to supports or reinforcing to prevent displacement during the concrete placement, as required by the current "Manual of Standard Practice" of the CRSI.

3.07 Field Quality Control

- A. ENGINEER shall inspect the reinforcing steel after it has been installed, and the reinforcing steel placement shall be approved by ENGINEER prior to placement of concrete.
- B. CONTRACTOR shall avoid displacement of the reinforcing steel during concrete placement.

End of Section

Section 03 3000 Cast-in-Place Concrete

Part 1 General

1.01 Scope of Work

- A. This Section includes all monolithic cast-in-place concrete work complete with materials, mixes, installation and testing.

1.02 Related Work Specified Elsewhere

- A. Section 03 1100: Concrete Forming
- B. Section 03 1500: Concrete Accessories
- C. Section 03 2000: Concrete Reinforcing
- D. Section 04 0511; Mortaring and Grouting
- E. Section 05 1200: Structural Steel Framing
- F. Section 05 5000: Metal Fabrications
- G. Section 07 1000: Dampproofing and Waterproofing
- H. Section 31 2319: Dewatering

1.03 Reference Standards

- A. Unless otherwise specified, the Work of this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. ACI - American Concrete Institute
 - 2. ASTM - ASTM International
 - 3. MDOT - Michigan Department of Transportation, Standard Specifications for Construction, latest edition

1.04 Reference Specifications

- A. The latest or current ACI Standards and Code Requirements for "Concrete and Reinforced Concrete" shall govern all concrete Work except where otherwise specified herein.

1.05 Testing Agency

- A. Inspections and tests required by this Section shall be performed by organizations acceptable to ENGINEER.

1.06 Allowable Tolerances

- A. See Section 03 1100, Concrete Forming, for the allowable tolerances for concrete surfaces.

1.07 Design Criteria

- A. Mixes shall be designed and tested for each size and gradation of aggregates and for each consistency intended for use. Design quantities and test results of each mix shall be submitted for review.

- B. Necessary construction joints are shown on the Plans. Modification of location or placement of construction joints not indicated on the Plans shall be subject to approval of ENGINEER. In general, they shall be located within the middle one-third of the span of slabs, beams, and girders unless a beam intersects a girder at this point, in which case the joint in the girder shall be offset a distance equal to twice the width of the beam.
- C. Joints in walls and columns shall be at the underside of floors, slabs, beams, or girders and at the tops of footings or floor slabs. Beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.
- D. Expansion joint locations and details shall be as shown on the Plans. In no case shall any fixed metal be continuous through an expansion joint.
- E. Keyways shall be provided in all joints where required to provide for either shear or watertightness. Unless otherwise required, the width of keys shall be at least one-third the thickness of the section at that point and their depth at least one-third their width.

1.08 Source Quality Control

- A. Furnish tests of cement and aggregates. Material sampling shall conform to the following ASTM Standards:
 - 1. CementC183
 - 2. AggregatesD75
- B. Testing shall be in accordance with applicable ASTM Standards to assure compliance with Specifications.
- C. Make tests for the following quantities, or fraction thereof:
 - 1. Cement550 tons (500 metric ton)
 - 2. Fine Aggregate2,000 Tons (1800 metric ton)
 - 3. Coarse Aggregate2,000 Tons (1800 metric ton)
- D. Use same brand cement for any given structure produced by a single mill unless otherwise provided by authorization of ENGINEER.

1.09 Submittals

- A. Submit Shop Drawings showing the location of joints. Included shall be a schedule of the concrete pouring. The location of joints and pouring schedule shall be subject to approval by ENGINEER.
- B. CONTRACTOR shall submit test reports for cement and aggregates to assure compliance with the Specifications.
- C. Concrete mixture designs and test data shall be submitted for review by ENGINEER with a written request for approval. No concrete shall be placed until CONTRACTOR has received such approval in writing. Each mixture report shall include:
 - 1. Slump on which design is based.
 - 2. Total gallons of water per cubic yard (l/m³).
 - 3. Brand, type, composition, and quantity of cement.
 - 4. Brand, type, composition, and quantity of pozzolan or other mineral admixtures.

5. Brand, type, composition, and quantity of ground granulated blast furnace slag.
 6. Specific gravity and gradation of each aggregate.
 7. Ratio of fine to total aggregates.
 8. Weight (surface dry) of each aggregate, lbs./c.y. (kg/m³).
 9. Brand, type, ASTM, active chemical ingredients, and quantity of each admixture.
 10. Air content.
 11. Compressive strength based on 7-day and 28-day compression tests.
 12. Time of initial set.
- D. Submit manufacturer's literature of abrasive wear resistant floor finish and of chemical curing compound for review by ENGINEER.
- E. Submit a sample concrete delivery ticket for review by ENGINEER.
- F. Submit tickets collected at the site of concrete placement accompanying each load of concrete. A printout system for producing these tickets in connection with automatic batching will be permitted.
1. Each ticket shall be serially numbered, show the charging time, quantity and grade of concrete, location of delivery and the signatures of inspectors at the plant and site. Transit mixed concrete tickets shall also include revolution counter reading at charging and mixing completion.
- G. Submit reports of the sampling and testing of slump, air content and strength performed.
- H. Submit reports of nondestructive, core and/or liquid retention testing required for acceptance of concrete in place.

1.10 Material Storage and Handling

- A. Materials shall be stored and handled in accordance with ACI 304 and as specified below.
- B. When permission is given to store cement in the open, a floor at least six (6) inches (150 mm) above the ground and a waterproof covering shall be provided and so placed as to insure runoff in case of rain.
- C. Cement sacks shall be thoroughly shaken when emptying sacks into the batch. Cement salvaged by CONTRACTOR by cleaning sacks mechanically or otherwise, or from discarded sacks of cement, shall not be used in the Work. The use of a fractional sack of cement will not be permitted unless the fractional part is measured by weight. At the time of its use in the Work, the cement shall be free from lumps.
- D. No aggregates which have become intermixed prior to proportioning shall be used. Sufficient aggregate shall be available at the site to preclude the possibility of damaging delays while placing the concrete.
- E. Cars used for shipping aggregates shall be clean and in good repair. The use of straw, marsh, hay or other similar materials for closing cracks or holes in cars will not be tolerated.
- F. Pozzolans and other cementitious materials shall be stored and handled in the manner of cement.
- G. Store and handle curing compound in a manner to prevent contamination.

1.11 Environmental Requirements

- A. Environmental requirements shall be in accordance with ACI 305 for hot weather concreting, and ACI 306 for cold weather concreting. Specific temperature requirements are contained in Article 2.10 of this Section for mixing and Article 3.13 of this Section for placing.

Part 2 Products

2.01 Materials - General

- A. Materials shall meet the requirements of ACI 301, ACI 318, and MDOT Specification, Division 9.
- B. Concrete materials shall be tested and inspected as the Work progresses. The review and/or check-test of the proposed materials, securing of production samples of materials at plant stockpiles and/or review of the manufacturer's reports for compliance will be performed at no cost to CONTRACTOR.
- C. Testing and inspection required due to substitution or change of materials requested by CONTRACTOR shall be at CONTRACTOR's expense.

2.02 Cement

- A. Cement shall be the type as indicated on the Plans or as specified.
- B. Type I and IA, conforming to ASTM C150, air-entraining Portland cement when special properties are not specified.
- C. Type III and IIIA, conforming to ASTM C150, air-entraining Portland cement for use when high-early strength is specified.
- D. Type IS and IS-A, conforming to ASTM C595, air-entraining Portland blast-furnace slag cement for use in general concrete construction.
- E. Type IP and IP-A, conforming to ASTM C595, air-entraining Portland-Pozzolan cement for use in general construction. The addition of suffix (MS) signifies that moderate sulfate resistance is specified. The addition of suffix (MH) signifies that moderate heat of hydration is specified.

2.03 Aggregates

- A. Washing will be required to eliminate the dust, clay, or silt coating. Aggregates which have been washed shall not be used sooner than 24 hours after washing, unless approved by the ENGINEER.
- B. Coarse aggregate shall be gravel or crushed rock, conforming to MDOT Section 902.03. Class 17A for members eight (8) inches (200 mm) or less in thickness and Class 6AA for other construction.
- C. Gravel shall consist of hard, clean, durable particles of rock or pebbles and shall be free from lumps of clay.
- D. Crushed rock shall consist of angular fragments of crushed hard heads or boulders or crushed igneous rock free from weathered rock and of uniform quality.

- E. Sieve and screen analyses determination of clay, silt, and dust content and percentages of objectionable particles will be based on dry weights and conform to MDOT Section 902.03, Table 902-1, "Grading Requirements for Coarse Aggregates, Dense-Graded Aggregates, and Open Graded Aggregates" and Table 902-2, "Physical Requirements for Coarse Aggregate, Dense Graded Aggregates and Open Graded Aggregates."
- F. Fine aggregate shall be sand size 2NS, MDOT, Section 902.09.
- G. Fine aggregates shall consist of sharp sand which shall be composed of clean, hard, durable grains and shall be free from lumps of clay and organic deleterious substances.
- H. Fine aggregates shall conform to MDOT Section 902.09 and Table 902-4, "Grading Requirements for Fine Aggregates."

2.04 Admixtures

- A. Admixtures shall be used to achieve concrete as indicated on the Plans or specified herein. Calcium chloride shall not be used.
 - 1. Air-entraining, conforming to ASTM C260.
 - 2. Pozzolan and Fly Ash, conforming to ASTM C618, Class C or F.
 - 3. Water reducing, conforming to ASTM C494.
 - 4. Retarder, conforming to ASTM C494.
 - 5. Plasticizer, conforming to ASTM C494.
 - 6. Ground granulated blast furnace slag conforming to ASTM C989, grade 100.
- B. Abrasive wear resistant floor finish shall be packaged, dry combination of Portland cement, graded Quartz aggregate and dispersing agents formulated to produce an abrasive and wear resistant monolithic surface.

2.05 Joint Filler

- A. See Section 03 1500, Concrete Accessories.

2.06 Water

- A. Water shall be free from oil, acid, alkali, organic matter, and any other deleterious substances. Water approved by the Local Board of Health may be used without testing. Water from other sources shall be tested before using.

2.07 Curing Compound

- A. Shall be adequate to prevent checking, cracking and loss of moisture, conforming to ASTM C309.

2.08 Mixes

- A. Concrete shall consist of a mixture of air-entraining Portland cement, coarse and fine aggregate, and water with admixtures if required. Admixtures shall not be used without ENGINEER's review. The mixture, combined in proportions, shall meet the requirements of MDOT, Specification Section 701, and ACI 211.1.
- B. Concrete shall be classified and proportioned on the basis of minimum compressive strength at 28 days when cured in a moist room at a temperature within the range of 65 to 75 degrees Fahrenheit (18 to 24 degrees Celsius). The desired strength of the concrete shall be shown on either the Plans or in the Specifications.

- C. Table 1 shows for each grade of concrete the minimum compressive strength, cement content, and the modulus of rupture. Concrete shall be 3,500 psi, Grade 3.5, unless otherwise shown on the plans.

Table 1 - Concrete Mixtures

Concrete Grade	Coarse Aggregate	Min Cement Content				Min. Comprehensive Strength at 28 Days (PSI/MPa)	Min. Modulus of Rupture at 28 Days (PSI/MPa)	% Air
		Type of Cement	lbs/yd ³	Sacks/yd ³	kg/m ³			
4.5	6AA	I, IA, IS, IS-A	658	7.0	390	4,500 / 31.0	725 / 5.0	4 - 6
4.0	6AA or 17A	I, IA, IS, IS-A	611	6.5	362	4,000 / 28.0	700 / 4.8	4 - 6
3.5	6AA or 17A	IS, IS-A, IP, IP-A	564	6.0	335	3,500 / 24.0	650 / 4.5	4 - 6
Notes: 1. Maximum water cement ration shall be 0.45 2. Structural concrete for walls and slabs shall be placed with a slump of four (4) inches (100 mm) maximum. 3. Ground granulated blast furnace slag (GGBFS) may be substituted for cement on a pound for pound basis from a minimum of 25% up to a maximum of 40% GGBFS and 60% cement 4. Fly ash may be substituted for cement on a pound for pound basis up to a maximum of 15% fly ash and 85% cement								

- D. Aggregates shall be proportioned by weight, except for small structures and for incidental Work requiring less than 10 cubic yards (7 m³) of concrete, in which case they may be proportioned by volume when approved by ENGINEER.
- E. Cement in bulk, when permitted, shall be proportioned by weight.
- F. When proportioned by volume, the amount of each aggregate required for a single batch shall be measured separately and accurately. Shovel methods of measuring will not be permitted. The unit of volumetric measurement shall be 1 cubic foot or 1 cubic meter.
- G. When proportioned by weight, the amount of each aggregate required for a single batch shall be weighed in a separate container. The equipment for weighing shall be of an approved type, and of such accuracy that there shall not be an error of more than 1 percent in any one batch.

2.09 Batching Admixtures

- A. The batching of admixtures to achieve and maintain production of the mix design of concrete shall be in accordance with ACI 212.
- B. If the air content is found to be less or greater than the specified amount, CONTRACTOR shall immediately discontinue Work and correct the air content.
- C. Decreasing the air content may be accomplished by blending air-entraining Portland cement with Portland cement, manufactured at the same mill, in a ratio which will reduce the air content to a value within the specified limits, this blending shall be reviewed by ENGINEER.
- D. Increasing the air content may be accomplished by adding to each batch a sufficient amount of air-entraining admixture to bring the air content up to the designed amount.

- E. Pozzolan and ground granulated blast furnace slag shall be proportioned based on the mix design approved by ENGINEER per Article 1.09 of this Section to produce watertight concrete.
- F. Water Reducer can be used to reduce the water requirement of concrete to obtain consistency of slump, modify workability, increase strength or any other approved use.

2.10 Temperature Limits of Mixture

- A. The temperature of the cement, at the time of delivery to the mixer, shall not exceed 165 degrees F (74°C). It may be required that it be stored at CONTRACTOR's expense until cooled to that temperature.
- B. The temperature limits of aggregates and water entering the mixer shall be as follows:

Limits of Temperature		
Component	Minimum	Maximum
Water	75°F (24°C)	140°F (60°C)
Fine Aggregate	65°F (18°C)	140°F (60°C)
Coarse Aggregate	65°F (18°C)	110°F (43°C)
Concrete (resulting)	60°F (15°C)	90°F (32°C)

2.11 Mixers and Mixing

- A. General:
 - 1. Concrete mixing operations shall be in accordance with ACI 304 and MDOT, Section 701, and shall be subject to random inspection during the progress of the Work at no charge to CONTRACTOR.
- B. Central Mixed Concrete:
 - 1. Mixers shall be capable of quickly and completely discharging without segregation or loss.
 - 2. Efficiency of the mixers shall be maintained at all times through repair or replacement of worn parts when necessary.
 - 3. Mixers shall be provided with readily adjustable, automatic devices which will measure the cement and water within one (1) percent and admixtures within three (3) percent.
 - 4. Drum of the mixer shall be kept free from hardened concrete and shall be completely emptied before recharging.
 - 5. Retempering or remixing concrete that has partially set will not be permitted.
 - 6. Mixer shall be cleaned thoroughly each time when out of operation for more than 1/2 hour.
 - 7. Recommended mixing time is a minimum time of one (1) minute for one (1) cubic yard (or cubic meter), with an additional 15 seconds for each additional cubic yard (or cubic meter).

8. Concrete shall be delivered to the site in clean, tight truck bodies designed for this purpose and painted with paraffin if necessary for easy dumping. Concrete at the point of delivery shall have the proper consistency and shall be free from segregation. Mechanical agitators in the truck bodies will be required if the period of time from the mixing plant to the point of dumping exceeds 30 minutes.
 9. No concrete shall be dumped if the elapsed time from the mixing plant to the point of dumping exceeds 60 minutes.
- C. Transit Mixed Concrete:
1. Transit-mix concrete shall be in accordance with ASTM C94. If transit-mix concrete is used, it shall meet all the foregoing requirements specified for central mixed concrete and, in addition, the following:
 - a. Batched materials shall be properly proportioned and in a dry state. The proper amount of water shall be added to the mixer on the trucks, and no additional water shall be added. No admixtures or accelerators shall be added except as herein noted, without the approval of ENGINEER.
 - b. Trucks shall not be loaded beyond their rated capacity and shall have mixing drums cleaned of all set-up materials at frequent intervals while in use. Trucks with leaking water valves shall not be used.
 - c. Recommended mixing speed should be no less than 12 revolutions per minute, with a minimum of 90 revolutions or until the mix is satisfactory.
 - d. Mixing shall be continuous after water is added to the mix in the drum, but no concrete shall be placed in the forms more than 90 minutes after water is added to the mix.
 - e. Truck-mixed concrete shall be delivered to the site of the Work and discharged from the mixer within the maximum period of 1-1/2 hours from the first introduction of water to the mix. Concrete which remains in the mixer after this period and any concrete which appears too stiff to be properly workable or which appears to have begun to take its initial set shall be rejected and removed from the site of the Work.
- D. OWNER may employ an independent testing laboratory to provide a qualified inspector to be present at the plant where batching of concrete occurs. The inspector shall verify the compliance of the mix with the Specifications and shall sign a form indicating the quantity of concrete and the concrete mixture of each load.

2.12 Change of Mixture

- A. If CONTRACTOR requests a change or substitution of approved batch proportioning, mixing, or delivery operations additional testing and/or inspection shall be at CONTRACTOR's expense.

2.13 Acceptable Manufacturers

- A. Acceptable manufacturers of abrasive wear resistant floor finish include: Master Builders Company "Mastercon Aggregate," Sonneborn Building Products "Harcot," or equal.

Part 3 Execution

3.01 Verification of Formwork, Reinforcing, and Subgrades

- A. CONTRACTOR shall inspect formwork, reinforcement and subgrades to confirm compliance with the related Work specified elsewhere.

3.02 Embedded Items

- A. CONTRACTOR shall verify the location, from certified vendor or applicable engineering drawings, of all embedded items including anchor bolts, wall sleeves, wall casting, railing post sleeves and miscellaneous pipes and conduits and shall install the items accurately at the locations determined.

3.03 Building in Other Work

- A. CONTRACTOR shall make all necessary provisions in concrete Work for other Work installed by this or other contractors, and build in all required steel beams, frames, curbs, expansion joints, inserts, hangers, pipes, floor drains, pipe trench covers and frames, anchors, sleeves, floor ducts, fiber and steel conduit, pipe hanger sockets, and all other Work furnished by either this or other contractors.
- B. CONTRACTOR shall build in all anchors, ties, etc., specified under brick and other Work, in faces of concrete Work which are to be faced with masonry, and any other Work shown or noted to be built into concrete. In addition, CONTRACTOR shall provide all openings and holes in concrete Work as shown or as needed to accommodate other Work.

3.04 Special Concrete

- A. CONTRACTOR shall verify the use and/or locations of watertight concrete and/or high-early strength concrete.

3.05 Preparation

- A. CONTRACTOR shall notify ENGINEER two (2) working days prior to placement of concrete.
- B. Before depositing new concrete on or against existing concrete the existing concrete shall be roughened, thoroughly cleaned of foreign matter and laitance and saturated with water. The cleaned and saturated surface of the hardened concrete, including vertical and inclined surfaces, shall be coated with a bonding agent or slushed with a minimum 2-inch (50 mm) thick coating of concrete without coarse aggregate grout against which the new concrete shall be placed before the mixture has attained its initial set.
- C. Before concrete is placed in any unit, the forms and the placing and fixing of all steel and incidental items shall be complete, and the forms, steel and adjacent concrete shall be thoroughly cleaned and wetted down.

- D. Where indicated on the Plans, CONTRACTOR shall bridge the subgrade with at least 2,000 psi (13.8 MPa), 3-inch (75 mm) thick lean concrete before placing the reinforcement. This shall be at no extra cost.
- E. No concrete shall be deposited in any unit until the area has been completely dewatered in accordance with Section 31 2319, Dewatering, and not until after CONTRACTOR has made satisfactory provisions to eliminate all possibility of water entering or flowing through the concrete while it is being poured or is taking its set. No concrete shall be placed under or on water.

3.06 Conveying

- A. Concrete handling equipment shall be of such a nature and shall be so located that the concrete after leaving the mixer will reach its destination with a minimum lapse of time, with no segregation, and loss of slump. Use of drop chutes, except at or in the forms, is prohibited.
- B. Interior hopper slope of concrete buckets shall be not less than 60 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least 5 times the nominal maximum size aggregate and the area of the gate opening shall be not less than 2 square feet (0.2 m²).
 - 1. Maximum dimension shall not be greater than twice the minimum dimension.
 - 2. Bucket gates shall be essentially grout tight when closed and may be manually, pneumatically or hydraulically operated except for buckets larger than 2 cubic yards (1.5 m³) shall not be manually operated.
 - 3. Design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.
- C. Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means for preventing segregation of the concrete at the transfer points and the point of placing.
- D. Concrete may be conveyed by positive displacement pump when authorized by ENGINEER. Pumping equipment shall be piston or squeeze pressure type. Pipeline shall be rigid steel pipe or heavy duty flexible rubber hose. Inside diameter of the pipe shall be at least 3 times the nominal maximum size coarse aggregate in the concrete mixture to be pumped. Maximum size coarse aggregate shall not be reduced to accommodate the pumps.
- E. Distance to be pumped shall not exceed limits recommended by the pump manufacturer. Concrete shall be supplied to the pump continuously. When pumping is completed, concrete remaining in the pipeline shall be ejected without contamination of concrete in place. After each operation, equipment shall be thoroughly cleaned, and flushing water shall be wasted outside of the forms.

3.07 Placing

- A. Concrete shall be so deposited as to maintain the top surface level, unless otherwise shown on the Plans, and also as to avoid any appreciable flow in the mass.

- B. Where placing operations involve dropping the concrete more than 3 feet (1 m) in the forms, it shall be deposited through sheet metal or other approved spouts or pipes. These spouts or pipes shall have suitable receiving hoppers at the upper ends, and the lower ends shall be kept within 6 inches (150 mm) of the newly placed concrete so as to prevent segregation and avoid spattering the reinforcing steel with mortar. Under no circumstances shall concrete that has partly hardened be deposited in the Work.
- C. Each layer of concrete shall be plastic when covered with the following layer and the forms shall be filled at a rate of vertical rise of not less than 2 feet (600 mm) per hour. Concrete vibrators shall penetrate the initial layer when placing the following layer. Vertical construction joints shall be provided as necessary to comply with these requirements.
- D. Concrete shall be placed and compacted in wall or column forms before any reinforcing steel is placed in the system to be supported by such walls or columns. The portion of any wall or column placed monolithically with a floor or roof slab shall not exceed 6 feet (1.8 m) of vertical height. Concrete in walls or columns shall set at least 2 hours before concrete is placed in the structural systems to be supported by such walls or columns.
- E. Concrete shall be set when top finished. Laitance, debris, and surplus water shall be removed from concrete surfaces at tops of forms by screeding, scraping, or other effective means. Wherever the top of a wall will be exposed to weathering, the forms shall be overfilled and after the concrete has settled, the excess shall be screeded off.
- F. No concrete shall be placed in contact with frozen ground. Time between charging and placement of concrete shall not exceed 1-1/2 hours.
- G. Concrete shall be compacted by continuous vibrating, tamping, spading or slicing. Care shall be taken to eliminate all voids and to provide full bond on reinforcing steel and embedded fixtures. Mechanical vibration shall be employed. Concrete shall be compacted and thoroughly worked with suitable tools combined with the use of vibrators applied internally and providing a frequency not less than 7,000 revolutions per minute. All such vibrating, including the methods and equipment, shall be subject to the review of ENGINEER.
- H. The time of vibrating in any area shall only be sufficient to get efficient compaction, but shall in no case be carried to the point where there is segregation of the fine and coarse materials of the mix. There shall be an absolute minimum of direct vibration of the steel or forms during the process of vibrating. Vibrators shall be inserted and withdrawn from the concrete at numerous locations, from 18 to 30 inches (450 to 750 mm) apart, but shall not be used to transport concrete within the forms. CONTRACTOR shall have a standby vibrator on the job site during all concrete pouring operations.

3.08 Finishing Unformed Surfaces

- A. The unformed surfaces of all concrete shall be screeded and given an initial float finish followed by steel troweling.
- B. Screeding shall provide a concrete surface conforming to the proper elevation and contour with all aggregates completely embedded in mortar. All screeded surfaces shall be free of surface irregularities with a height or depth in excess of 1/4 inch (5 mm) as measured from a 10-foot (3 m) straightedge.

- C. Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance with no unnecessary working of the surface. Floating shall be performed with hand floats or suitable mechanical compactor floats.
- D. Troweling shall be performed after the second floating when the surface has hardened sufficiently to prevent an excess of fines being drawn to the surface. Troweling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks. The top surface of driveways, and sidewalks shall be given a broomed finish after troweling.
- E. Unless specified to be beveled, exposed edges of floated or troweled surfaces shall be edged with a tool having 1/4 inch (5 mm) corner radius.

3.09 Finishing Formed Surfaces

- A. After removal of forms, the finishing of all concrete surfaces shall be started as soon as its condition will permit.
- B. Grind all seams, fins or projections flush with the concrete surface.
- C. Fill and point all honeycomb, tie holes and voids.
- D. Dampen the surface with water and apply a cement and silica sand slurry to the entire surface to fill small defects and air voids.
- E. Remove excess slurry from concrete. Surfaces to be finished shall receive an application of dry Portland cement which shall be rubbed into the slightly dampened surface with a suitable cloth.
- F. After pointing and removal of projections as specified herein, exposed surfaces of concrete, including walls, columns, beams, pilasters and the undersides of slabs, shall be given a rubbed surface finish.

3.10 Floors

- A. Concrete floor finish shall be applied to all building floors not receiving further floor finish. At these locations, the concrete shall be brought to the proper elevation and screeded. The surface shall be given two (2) steel trowelings when the concrete has set sufficiently to finish smoothly. Floors shall be sloped uniformly toward floor drains at a slope of 1/8 inch per foot (10 mm per meter).
- B. Concrete finish on steps and loading platforms shall be wood troweled to true and uniform surface and then steel troweled. The surface shall then be slightly roughened with a broom or by dragging burlap across the surface.
- C. Concrete floors shall be finished with an abrasive resistant floor finish in the areas noted on the finish schedule on the Plans. Premixed floor hardener shall be applied to the surface of the freshly floated concrete floor, in strict accordance with the manufacturer's directions. Color to be selected by OWNER.

3.11 Expansion Joints

- A. Comply with the requirements of Section 03 1500, Concrete Accessories. Expansion joints shall have removable polystyrene joint caps secured to the top thereof and shall be accurately positioned and secured against displacement to clean, smooth concrete surfaces.
- B. Joint caps shall be of the size required to install filler strips at the desired level below the finished concrete surface and to form the groove for the joint sealant to the size shown on the Plans.
- C. Joint caps shall not be removed until after the concrete curing period.

3.12 Concrete Curing

- A. Concrete shall be cured for a period not less than 7 consecutive days. CONTRACTOR shall have adequate equipment and curing material on the job site before concrete placement begins, and it shall be adequate to prevent checking and cracking and loss of moisture from all the surfaces of the concrete. Concrete shall be protected from rain, flowing water, wind and the direct rays of the sun. Openings in concrete shall be sealed to prevent drying of the concrete during the curing period.
- B. Curing compounds shall not be used on surfaces to which additional concrete or other material are to be bonded.
- C. Curing compounds when used shall be applied in strict accordance with the manufacturer's recommendations.
- D. Concrete cured with water shall be kept wet by covering with ponded water or fog spraying to keep all surfaces continuously wet.
- E. Horizontal construction joints and finished surfaces cured with sand shall be covered a minimum thickness of 1-inch (25 mm), uniformly, and kept saturated during the curing period.
- F. Burlap used for curing shall be treated to resist rot and fire and free of sizing or any substances that are injurious to Portland cement or cause discoloration. Strips shall be lapped by half widths. The burlap shall be saturated with water after placement and during the curing period.
- G. Straw or hay shall be in a layer no less than 6 inches (150 mm) thick and held in place by screens, wire or other means to prevent dispersion by the wind. Care shall be observed to avoid discoloration of the concrete surface from the vegetable fibers and for the flammability of the material. The straw shall be saturated with water after placement and during the curing period.

3.13 Environmental Conditions

- A. General:
 - 1. CONTRACTOR shall provide cold or hot weather protection in accordance with ACI and as specified herein. There shall be no additional cost for hot or cold weather protection of the concrete.

B. Cold Weather Protection:

1. When placing concrete in cold weather, CONTRACTOR shall plan and prosecute his Work in a manner which shall assure results free from damage through freezing, contraction, and loss of concrete strength.
2. No concrete shall be poured when the surrounding temperature is below 40 degrees Fahrenheit (4 degrees Celsius), unless the aggregates and water are properly heated. Concrete which has been poured at higher temperatures but has not attained a strength equal to 75% of the required strength of the class of concrete involved, shall be housed and protected in accordance with the provisions of this Section whenever the surrounding temperature falls below 40 degrees Fahrenheit (4 degrees Celsius).
3. Application of heat to the materials shall be made in a manner which will keep these materials clean and free from injurious substances.
4. Aggregates may be heated only by steam coils or steam jets, except in the case of small quantities of concrete when other methods may be approved by the ENGINEER. A sufficient quantity of properly heated aggregates shall be on hand prior to starting the pouring of any unit.
5. Concrete shall be properly housed with canvas, burlap, or other windproof material in such a manner that any necessary removal of the forms or finishing of the concrete can proceed without undue damage to the concrete from the elements.
6. Heating of the housing shall be done in a manner which will maintain a temperature between 50 and 70 degrees Fahrenheit (10 and 20 degrees Celsius), at all times for at least 5 days after the pour is complete and 12 hours before the pour begins.
7. Supplemental heating units shall have exhaust vented to the exterior and shall not cause deleterious reactions or deposits to occur to concrete.

C. Hot Weather Protection:

1. Concrete deposited in hot weather shall not have a placing temperature that will cause difficulty from loss of slump, flash set, or cold joints. Concrete temperature shall be less than 90 degrees Fahrenheit (32 degrees Celsius).
2. In hot weather, suitable precautions shall be taken to avoid drying of the concrete prior to finishing operations. Use of windbreaks, sunshades, fog sprays, or other devices shall be provided.

3.14 Addition of Water

- A. To increase workability, adding water to the mix shall be limited to a one time addition of 1 gallon of water per cubic yard of concrete (5 liters per cubic meter) and mixed with a minimum of 30 revolutions at a rate of 12 to 15 revolutions per minute. Addition of water shall be within the slump requirements.

3.15 Concrete Delivery Ticket

- A. A ticket system shall be used for recording the transportation of concrete from the batching plant to point of delivery. This ticket shall be issued to the truck operator at the point of loading and given to ENGINEER upon delivery. Ticket shall as a minimum indicate the time of mixer charging, quantity of concrete, type of mixture including amount of cement, and the plant where the concrete was batched.

3.16 Concrete Delivery Rejection

- A. Concrete not permitted for inclusion in the Work by ENGINEER shall be removed from the site. Rejection of concrete will be determined through concrete testing and elapsed time from mixer charging to delivery.

3.17 Concrete Testing at Placement

- A. General:
 - 1. Tests shall be made of fresh concrete for each 50 cubic yards (40 m³), or whenever consistency appears to vary. Sampling and testing of slump, air content and strength will be performed at no cost to CONTRACTOR.
 - 2. Composite samples shall be secured in accordance with the Method of Sampling Fresh Concrete, ASTM C172.
- B. Slump Test:
 - 1. Slump Test shall be in accordance with ASTM C143. CONTRACTOR shall use the least slump possible consistent with workability for proper placing of the various classifications of concrete.
 - 2. A tolerance of up to 1-inch (25 mm) above the indicated maximum slump shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, whichever is fewer, does not exceed the maximum limit.
- C. Air Content:
 - 1. Air content of normal weight concrete will be determined in accordance with Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method, ASTM C231.
- D. Compressive Strength:
 - 1. A set of cylinders for compressive strength tests will consist of four cylinders per each set.
 - 2. Molding and curing specimens from each set shall be in accordance with Method of Making and Curing Concrete Test Specimens in the Field, ASTM C31. Any deviations from the requirements of this Standard shall be recorded in the test report.
 - 3. Testing specimens will be in accordance with Method of Test for Compressive Strength of Cylindrical Concrete Specimens, ASTM C39. One (1) specimen shall be tested at seven (7) days for information and two (2) shall be tested at 28 days for acceptance.

- a. The acceptance test results shall be the average of the strengths of the two (2) specimens tested at 28 days. If one (1) specimen in a test manifests evidence of improper sampling, molding or testing, it shall be discarded and the strength of the remaining cylinder shall be considered the test result.
4. The strength level of the concrete will be considered satisfactory so long as the averages of all 28 day strength test results equal or exceed the specified 28-day strength and no individual strength test result falls below the specified 28-day strength by more than 500 psi (3.4 MPa).
5. If the strength test is not acceptable, further testing shall be performed to qualify the concrete.

3.18 Testing of Concrete in Place

- A. Additional testing of materials or concrete occasioned by their failure by test or inspection to meet specification requirements shall be at the expense of CONTRACTOR.
- B. Testing by impact hammer, sonoscope, or other nondestructive device may be permitted by ENGINEER to determine relative strengths at various locations in the structure as an aid in evaluating concrete strength in place or for selecting areas to be cored. Such tests, unless properly calibrated and correlated with other test data, shall not be used as a basis for acceptance or rejection.
- C. When required by ENGINEER, cores at least two (2) inches (50 mm) in diameter shall be obtained and tested in accordance with Methods of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete, ASTM C42.
- D. If the concrete in the structure will be dry under service conditions, the cores shall be air dried (temperature 60 to 80 degrees Fahrenheit (15 to 25 degrees Celsius), relative humidity less than 60%) for 7 days before test and shall be tested dry.
- E. If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be tested after moisture conditioning in accordance with ASTM C42.
- F. At least 3 representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores shall be determined by ENGINEER so as to least impair the strength of the structure. If, before testing, one or more of the cores shows evidence of having been damaged subsequent to or during removal from the structure, it shall be replaced.
- G. Concrete in the area represented by a core test will be considered adequate if the average strength of the cores is equal to at least 85% of and if no single core is less than 75% of the specified 28-day strength.
- H. Core holes shall be filled by low slump concrete or mortar.

3.19 Retention Testing

- A. Tanks or structures designed to hold or retain water, wastewater or other liquids shall be retention tested.

- C. To test a tank or structure for leakage, CONTRACTOR shall clean, disinfect (if required) and fill the tank or structure with water to its maximum level.
- D. The water shall be allowed to remain 24 hours with all associated valves and appurtenances tightly closed.
- E. During this 24-hour period, the water level as measured by a hook gage shall show no measurable loss.
- F. If this test fails, CONTRACTOR shall dewater the tank or structure, make such repairs as necessary to achieve a watertight tank or structure, clean, disinfect (if required), and retest.
- G. Tests and repairs shall be repeated until the tank or structure is accepted by ENGINEER.

3.20 Defective Concrete

- A. If, in the opinion of ENGINEER, the defects in the concrete are of such a nature as to warrant condemnation, that portion of the pour may be ordered replaced in its entirety and CONTRACTOR shall promptly replace same without additional compensation.
- B. Defective concrete shall be repaired by cutting out the defective area and placing new concrete which shall be formed with keys, dovetails or anchors to attach it securely in place.

End of Section

Section 03 3103

Concrete Repair and Rehabilitation

Part 1 General

1.01 Section Includes

- A. Furnishing of materials, labor, tools, and equipment necessary to repair, patch, and restore poorly placed, or deteriorated concrete; and repair expansion joints. This includes removal, surface preparation and installation of repair materials at deteriorated areas, cracks, and openings in concrete floors and walls, as indicated on the drawings and specified herein.

1.02 Related Sections

- A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
 - 1. Section 01 1100: Summary of Work
 - 2. Section 01 2200: Unit Prices
 - 3. Section 01 3300: Submittal Procedure
 - 4. Section 01 5000: Temporary Facilities and Controls
 - 5. Section 01 6000: Product Requirements
 - 6. Section 03 2500: Concrete Accessories
 - 7. Section 33 0130.13: Cleaning of Sewer Utilities
 - 8. Section 33 0130.16: Television Inspection of Sewer Utilities

1.03 Reference Standards

- A. Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. AASHTO M43 - Standard Specification for Sizes of Aggregate for Road and Bridge Construction
 - 2. ACI 234R - Guide for the Use of Silica Fume in Concrete
 - 3. ACI 305R - Hot Weather Concreting
 - 4. ACI 306R - Cold Weather Concreting
 - 5. ACI 308- Standard Practice for Curing Concrete
 - 6. ASTM A193/A193M - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
 - 7. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes
 - 8. ASTM C109 - Test Method for Compressive Strength of Hydraulic Cement Mortars
 - 9. ASTM C127 - Standard Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
 - 10. ASTM C882 - Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete

11. ASTM D1042 - Standard Test Method for Linear Dimensional Changes of Plastics Caused by Exposure to Heat and Moisture
12. ASTM D3574 - Standard Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams
13. ASTM G109 - Standard Test Method for Determining Effects of Chemical Admixtures on Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments
14. OSHA - Occupational Safety and Health Act of 1970

1.04 Submittals

- A. Submit manufacturer's data completely describing structural repair concrete materials in accordance with Section 01 3300, Submittal Procedures, including:
 1. Product Data
 2. Certificate of Compliance
 3. Manufacturer's Instructions

1.05 Quality Assurance

- A. Manufacturer Qualifications: Manufacturer of the specified product shall have been in existence, for a minimum of ten (10) years.
- B. Pre-install Conference: Prior to beginning any concrete repair or rehabilitation work, CONTRACTOR shall meet with ENGINEER to thoroughly discuss the proposed work, techniques and schedule. Representatives of the Manufacturer and Installer of repair and rehabilitation materials, as well as the independent testing agency, shall attend the pre-installation conference.

1.06 Delivery, Storage and Handling

- A. Equipment shipment, protection and storage shall conform to the requirements specified in Section 01 6000.
- B. Deliver the specified product in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers.
- C. Store and condition the specified product as recommended by the manufacturer.
- D. Store in a suitable location approved by ENGINEER at all times. Keep area clean and accessible. Comply with health and fire regulations including the Occupational Safety and Health Act of 1970.
- E. Handle materials carefully to prevent inclusion of foreign materials.
- F. Do not open containers or mix components until necessary preparatory work has been completed and application work will start immediately.

1.07 Warranty

- A. Materials specified herein shall be certified by the Manufacturer for the specified purpose. Manufacturer shall warrant the raw materials to be free from defects for a minimum of one (1) year from the date of installation and acceptance by OWNER. If Manufacturer's standard warranty length exceeds one (1) year, CONTRACTOR shall provide OWNER with Manufacturer's standard warranty.

- B. CONTRACTOR shall warrant the Work for a period of one (1) year. During the warranty period any defect, which may materially affect the integrity, strength, function and/or operation of the pipe, manhole or structure, shall be repaired at CONTRACTOR's expense.
- C. Manufacturer's warranty period shall run concurrently with CONTRACTOR's warranty period. No exception to this provision shall be allowed.

Part 2 Products

2.01 Manufacturers

- A. Repair Mortar:
 - 1. Sikatop 122 Plus, SikaTop 123 Plus, SikaTop 126 Plus by Sika Corporation; or
 - 2. ENGINEER approval equal.
- B. Expansion Joint Repair System:
 - 1. Sikadur Combiflex by Sika Corporation; or
 - 2. ENGINEER approval equal.
- C. Exposed Rebar Repair and Scrub Coats:
 - 1. SikaTop Armatec 110 EpoCem by Sika Corporation; or
 - 2. ENGINEER approval equal.
- D. Cementitious Coating:
 - 1. Sikatop 144 by Sika Chemical Corporation; or
 - 2. ENGINEER approval equal.
- E. Crack Injection (Hydrophilic Polyurethane Chemical Grout):
 - 1. SikaFix HH by Sika Chemical Corporation; or
 - 2. ENGINEER approval equal.
- F. Joint sealants (Polyurethane Elastomeric Sealant):
 - 1. Sikaflex-2C by Sika Chemical Corporation; or
 - 2. ENGINEER approval equal.
- G. Bonding agent:
 - 1. SikaTop Armatec 110 EpoCem cement-based, epoxy-modified bonding agent; or
 - 2. ENGINEER approval equal.
- H. Structural Crack Repair System:
 - 1. Sikadur 35, Hi-Mod LV and Sikadur 31, Hi-Mod gel, by Sika Corporation; or
 - 2. Eucopoxy Injection Resin, by Euclid Chemical Company; or
 - 3. ENGINEER approval equal.
- I. Non-Structural Crack Repair System:
 - 1. SikaFix HH LV, by Sika Corporation; or
 - 2. Hydro Active Flex SLV, by De Neef Construction Chemicals, Inc.; or
 - 3. ENGINEER approval equal.

2.02 Materials

A. Mixes:

1. Repair Mortar:
2. Repair mortar shall be a prepackaged cement-based product specifically formulated for the repair of concrete surface defects. Mortar shall be a two-component polymer-modified, Portland cement, fast setting, trowel-grade mortar. Repair mortar shall be enhanced with a penetrating corrosion inhibitor.
3. Expansion Joint Repair System:
 - a. Joint repair system shall consist of two components, an epoxy resin adhesive and hypalon sheeting.
4. Epoxy Resin Adhesive: Provide a two-component epoxy resin as follows:
 - a. Component A shall be a modified epoxy resin of the epichlorohydrin bisphenol A type containing suitable viscosity control agents and pigments. It shall not contain butyl glycidyl ether.
 - b. Component B shall be primarily a reaction product of a selected amine blend with an epoxy resin of the epichlorohydrin bisphenol A type containing suitable viscosity control agents, pigments, and accelerators.
5. Hypalon Sheeting: Provide Hypalon sheeting as follows:
 - a. Hypalon sheeting shall consist of Hypalon rubber. It shall be perforated along the bonding edge to provide a mechanical key. It shall have the ability to be vulcanized with hydrocarbon solvent to permit its adhesion to an epoxy resin adhesive.
 - b. The sheeting shall be provided in 12-inch width with a thickness of 40 mils.
 - c. The sheeting shall be able to be lapped or seamed by heat or by aromatic hydrosolvent strip.
 - d. The sheeting shall be supplied with a removable center expansion strip.
 - e. Batten bars and anchors batten bars shall be 2-inch wide by ¼-inch thick stainless steel bars conforming to ASTM A276, Type 316 stainless steel material. Anchors shall be 3/8-inch diameter stainless steel bolts conforming to ASTM A193, Type 316 stainless steel material.
6. Exposed Rebar Repair:
 - a. Exposed reinforcing repair system shall consist of two components, a first application of a corrosion inhibitor and then a final application of a protective slurry mortar.
7. Corrosion Inhibitor:
 - a. Corrosion inhibitor shall penetrate the hardened concrete surface and form a protective layer on the reinforcement. It shall have the following properties:

- (1) The product shall not change the substrate's color, appearance, or texture.
 - (2) Penetration (SNMS Analysis): 1/10 to 4/5 inches/day.
 - (3) Coating thickness (XPS and SIMS Analysis): 100-1000 angstroms.
 - (4) Corrosion Current Reduction (ASTM G109 Cracked Beam Test): 65% at 1 year.
 - (5) Chloride Displacement (XPS and SIMS Analysis): Passes.
 - (6) Effectiveness in Carbonated Conditions (Electrochemical): Passes.
 - (7) The product must not form a vapor barrier.
 - (8) The product must be environmentally sound.
 - (9) Post-application verification (Chromatography Plate Test): Passes.
 - (10) Longevity (10 Year Accelerated Weather Testing): Passes.
8. Protective Slurry Mortar:
 - a. Protective slurry mortar shall be a two-component, polymer-modified, cementitious waterproofing, and protective slurry mortar. Provide two coats at a rate of 50 sq. ft./gal./coat.
 9. Cementitious Coating:
 - a. Cementitious Coating: Provide a polymer-modified, 2 component, cementitious coating which is specifically designed to be a fine-textured, abrasion-resisting coating, and for dampproofing/waterproofing.
 10. Structural Crack Repair System:
 - a. Epoxy for injection shall be low-viscosity, high-modulus moisture insensitive type.
 11. Non-Structural Crack Repair System:
 - a. Hydrophobic Polyurethane Chemical Grout:
 - (1) Provide hydrophobic polyurethane that forms a flexible gasket.
 12. Joint Sealant:
 - a. Joint shall be filled with joint filler material in accordance with Section 03 2500, Concrete Accessories.
 13. Concrete Topping:
 - a. Topping: Silica fume concrete topping
 - b. Concrete topping shall conform to the following:

- (1) Aggregates: 2NS and 26A conforming to MDOT requirements for fine aggregate for Portland cement concrete. Coarse aggregate shall conform to AASHTO M43, Size 78 (coarse aggregate must be 100 percent crushed and absorption must not exceed 2.5 percent as determined by ASTM C127).
- (2) Slump: 4 to 6 inches.
- (3) Air content: 5.0% to 8.0%.
- (4) Cement: 618 pounds of Type I Portland cement.
- (5) Dry Densified Silica Fume: 40 pounds.
- (6) Net Mix Water: 275 pounds (maximum water to cementitious material ratio: 0.43).
- (7) Fine Aggregate: 1273 pounds.
- (8) Coarse Aggregate: 1601 pounds.

2.03 Performance and Design Criteria

A. Repair mortar shall have the following properties:

Physical Property	Value	ASTM Standard
Compressive Strength (minimum)		
at 1 day	2000 psi	C109
at 28 days	6000 psi	
Bond Strength (minimum)		
at 28 days	1800 psi	C882*

*Modified for use with repair mortars.

B. Non-Structural Crack Repair System:

1. Shrinkage limit shall not exceed 4.0 percent in accordance with ASTM D1042.
2. Minimum elongation of 250 percent in accordance with ASTM D3574.
3. Minimum tensile strength of 150 psi in accordance with ASTM C3574.

Part 3 Execution

3.01 Installation

A. Existing Conditions:

1. Hot Weather: ACI 305R
2. Cold Weather: ACI 306R
3. Do not place concrete repair mortar during precipitation, unless adequate protection is provided.
4. Coordinate coatings application with other trades to assure adequate illumination, ventilation, and dust-free environment during application and curing of coatings.

B. Examination:

1. CONTRACTOR shall examine areas and conditions under which repair work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

C. Preparation:

1. Surface Preparation for Spall Repair:

- a. Entire area to be repaired shall have all laitance, foreign material, and unsound concrete removed by chipping and/or abrasive blasting or hydroblasting. Surface shall be further roughened as specified herein. Where non-shrink grout or repair mortar is used, any additional surface preparation steps recommended by the Manufacturer shall be performed.
- b. Where repair concrete, shotcrete, or cement grout is used, and a bonding agent is not required, or where the repair mortar or non-shrink grout manufacturer recommends a wet or saturated surface, water shall be delivered to the surface continuously for a minimum of four (4) hours.
 - (1) Where large surface areas are to be repaired, fog spray nozzles mounted on stands shall be provided in sufficient numbers such that the entire surface to be repaired is in contact with the fog spray cloud.
 - (2) Concrete shall be prevented from drying until after the repair operation is completed.
 - (3) Unrepaired surfaces shall be rewetted by water spray on at least a daily basis.
 - (4) Should more than four (4) days to be elapsed without rewetting the unrepaired surfaces, the original saturating procedure shall be repeated.
 - (5) Standing water in areas to be repaired shall be removed prior to placement of repair material. Means to remove excess water from the structure shall be provided.
- c. Where the repair material Manufacturer recommends the use of an epoxy bonding agent, the Manufacturer's recommendations of both the repair material and bonding agent shall be followed.
- d. Care shall be taken to fully consolidate the repair material, completely filling all portions of the area to be filled.
- e. Repair surface shall be brought into alignment with the adjacent existing surfaces to provide a uniform, even surface. Repair surface shall match adjacent existing surfaces in texture and shall receive any coatings or surface treatments which had been provided for the existing surface.

2. Curing:
 - a. Curing of repair mortar and non-shrink grout shall be according to the Manufacturer's recommendations except that the minimum cure period shall be three (3) days.
- D. Treatment of Surface Defects:
 1. Surface defects are depressions in a concrete surface which do not extend all the way through the member. Depressions can result from the removal of an embedded item, the removal of an intersecting concrete member, physical damage, unrepaired rock pockets created during original placement, or spalls from corroded reinforcing steel or other embeds.
 2. Preparation:
 - a. Loose, damaged concrete shall be removed by chipping to sound material.
 - b. Where existing reinforcing bars are exposed, concrete shall be removed to a minimum of one inch all around the bars. If the existing bars are cut through, cracked, or the cross-sectional area is reduced by more than 25 percent, ENGINEER shall be notified immediately.
 - c. Perimeter of the damaged area shall be score cut to a minimum depth of 0.5-inch and a maximum depth so as to not cut any existing reinforcing steel. Existing concrete shall be chipped up to the score line so that the minimum thickness of repair mortar is 0.5-inch.
 3. Repair Material:
 - a. Repair of surface defects in members which are normally in contact with water or soil or in the interior surfaces of enclosed chambers which contain water shall be made only with repair mortar.
 - b. Repair of other surface defects may be by the application of repair mortar, repair concrete, shotcrete, or cement grout, as appropriate.
- E. Patching of Holes in Concrete:
 1. For holes larger than 48 inches, see the Contract Drawings for reinforcement details.
- F. Patching of Lined Holes:
 1. Patching of lined holes applies to openings which have embedded material over all or a portion of the inside edge. Unless indicated to remain in place on the Contract Drawings or by ENGINEER, such embedded materials shall be removed, and the remaining hole repaired as specified above. Requirements for repairing holes in concrete specified above shall apply as modified herein.
 2. Where embedded material is allowed to remain, it shall be trimmed back a minimum of 2 inches from the concrete surface. Embedded material shall be roughened or abraded to promote good bonding to the repair material. Any substance that interferes with good bonding shall be completely removed.

3. Any embedded item that is not securely and permanently anchored into the concrete shall be completely removed.
4. Embedded items which are larger than 12-inches in their least dimension shall be completely removed unless they are composed of a metal to which reinforcing steel can be welded. Where reinforcement is required, it shall be welded to the embedded metal.
5. The following additional requirements apply to concrete members which are in contact with water or soil.
 - a. Lined openings which are less than 4-inches in their least dimension shall be filled with epoxy grout.
 - b. Lined openings which are greater than 4-inches but less than 12-inches in their least dimension shall be coated with an epoxy bonding agent prior to being filled with Class I non-shrink grout.
 - c. Lined openings which are greater than 12-inches in their least dimension shall be coated with an epoxy bonding agent and shall have a hydrophilic rubber waterstop or bead of hydrophilic sealant installed to the interior of the opening at the wall centerline prior to being filled with any approved repair material.

G. Repair of Deteriorated Concrete:

1. Repair of deteriorated concrete pertains to concrete which has been damaged due to corrosion of reinforcing steel, physical damage due to abrasion, and damage due to chemical attack. The only material acceptable for surface repair is repair mortar as specified herein. Where the repaired surface is to be subsequently covered with a PVC liner material, the finishing details shall be coordinated with the needs for installing the liner material.
2. Surface Preparation:
 - a. Loose, broken, softened, and acid contaminated concrete shall be removed by abrasive blasting and chipping down to sound, uncontaminated concrete.
 - b. When the removal of deteriorated concrete is completed, CONTRACTOR shall notify ENGINEER and allow up to two (2) weeks for ENGINEER to inspect the surface, determine if additional concrete must be removed, and to develop any special repair details that may be needed. Should it be determined that additional concrete must be removed to reach sound, uncontaminated material, another two (2) week period shall be scheduled for further evaluation by ENGINEER after the end of the additional removal.
 - c. Additional surface preparation shall follow the recommendations of the repair mortar Manufacturer.
 - d. Isolated areas of exposed reinforcing bars shall be treated as required for repair of surface defects. If extensive areas of reinforcement are uncovered after removal of deteriorated concrete, repair methods shall be as determined by ENGINEER.

H. Repair Mortar Placement:

1. Procedures recommended by the manufacturer for the mixing and placement of the repair mortar shall be followed.
2. After the initial mixing of the repair mortar, additional water shall not be added to change the consistency should the mix begin to stiffen.
3. Repair mortar shall be placed to a minimum thickness as recommended by the manufacturer, but not less than 0.50-inch.
 - a. Where removal of deteriorated concrete results in a repair thickness of less than 0.5 inch to return to original concrete surface location in isolated areas totaling less than 10 percent of the total repair area, additional concrete shall be removed to obtain the 0.5-inch thickness.
 - b. Where the area with repair thickness of less than 0.5 inch exceeds 10 percent of the total repair area, notify ENGINEER. In any case, repair mortar shall be added so that the minimum cover over existing reinforcing steel is 2 inches.
 - c. CONTRACTOR shall not place repair mortar to create locally raised areas. Where there is a transition with wall surfaces which are not in need of repair, the repair mortar shall not be feathered at the transition. A score line shall be sawcut to not less than the minimum repair mortar depth and concrete chipped out to it to form the transition. Care shall be taken to not cut or otherwise damage any reinforcing steel.
4. Where the least dimension of the placement in width or thickness, exceeds 4-inches, the repair mortar shall be extended by addition of aggregate as recommended by the Manufacturer.
5. Repair mortar shall be placed to an even, uniform plane to restore the member to its original surface. Tolerance for being out of plane shall be such that the gap between a 12-inch straight edge and the repair mortar surface does not exceed 0.125-inch and the gap between a 48-inch straight edge and the repair mortar surface does not exceed 0.25-inch. This shall apply to straight edges placed in any orientation at any location.

I. Finishing:

1. Repair mortar shall receive a smooth, steel trowel finish.
2. When completed, there shall be no sharp edges. Exterior corners, such as at penetrations, shall be made with a 1-inch radius. Interior corners shall be square except corners to receive PVC lining shall be made with a 2-inch repair mortar fillet.

J. Curing:

1. Curing shall be performed as recommended by the repair mortar Manufacturer except that the cure period shall be at least 24 hours and shall be by means of a continuous fog spray.
2. If the Manufacturer recommends the use of a curing compound, no material shall be used that would interfere with the bond of the protective coating system or adhesive used for placing PVC lining, where required.

K. Treatment of Expansion Joint Repair:

1. Surfaces to be repaired shall have all laitance, foreign material, and unsound concrete removed by chipping and/or abrasive blasting or hydroblasting.
2. Follow other surface preparation and application specifications as recommended by Manufacturer.
3. Existing material and debris shall be removed from within joint.

L. Exposed Rebar:

1. Entire area to be repaired shall have all corrosion, foreign materials, and unsound concrete by means of abrasive blasting or hydroblasting.
2. Surface shall be visually dry before application of the corrosion inhibitor. The corrosion inhibitor shall be placed liberally to achieve 100 square feet per gallon of coverage in two (2) or more coats by allowing it to soak into the substrate. The waiting time between coats is a minimum of one hour. Apply by use of rollers, brushes, or hand-pressure spray equipment.
3. After the last coat of the corrosion inhibitor is applied, a minimum curing time of 24 hours is required.
4. High pressure wash all surfaces to remove filmy residue which is left on the surface by the corrosion inhibitor. Residue acts like bond breaker and must be removed before mortar coating.
5. For mortar coating, refer to Article 3.06 of this Section.

M. Cementitious Coating:

1. Surfaces to be repaired shall have laitance, foreign material, and unsound concrete removed by chipping and/or abrasive blasting or hydroblasting.
2. Follow other surface preparation and application specifications as recommended by Manufacturer.

N. Concrete Topping:

1. When placing silica fume concrete, the placing, finishing, and curing procedures must all be performed in a continuous operation without interruption. Prior to initiating placement of silica fume concrete, CONTRACTOR must be prepared, including provisions for adequate manpower, back-up equipment (vibrators, vibratory screeds, power sprayers, standby pumps), and the proper curing materials and equipment.
2. When finishing silica fume concrete, CONTRACTOR shall take measures as described in ACI 234R, 305R, and 308 to establish the timing and procedures for finishing, and to protect against plastic shrinkage cracking.
 - a. CONTRACTOR shall refer to Figure 2.1.5 of ACI 305R to estimate the rate of evaporation from fresh concrete.
 - b. When the predicted rate of evaporation exceeds 0.05 lb/SF/hr during the placement, CONTRACTOR shall take measures to reduce moisture loss as described in ACI 305R and 308, which may include the use of compressed air/water misting, evaporation retarders, or other acceptable means.

- c. A monomolecular film product that aids in retarding the evaporation and acts as a finishing aid may be used provided the approval of ENGINEER is obtained in advance. CONTRACTOR shall take caution not to over-finish silica fume concrete.
- 3. When curing silica fume concrete, it is imperative that protective measures are taken during placement and that curing procedures begin immediately after the finishing process is complete, as described in ACI 234R, 305R, and 308. Wet curing methods shall be utilized as follows:
 - a. Apply a continuous fog spray of water to screeded and finished concrete. Provide fogging equipment capable of spreading a fine mist over concrete surfaces without ponding water. Continue fogging behind the final floating operation until placement and activation of the wet cure system. Do not fog concrete surfaces to aid surface finishing.
 - b. Prepare clean, contaminate-free burlap by soaking in clean water for at least 12 hours before beginning concrete placement. Immediately before use, drape or suspend the burlap sheeting vertically to remove excess water. Cover concrete surfaces with wet burlap when the concrete surface can support it without deformation. Do not allow in-place burlap to dry. Do not use Burlene, or other products with impervious surfaces.
 - c. Install a network of soaker hoses over wet burlap when the concrete surface will support it without deformation. Use soaker hoses perforated throughout the lengths, within the curing limits. Use non-perforated hose outside the curing limits. Ensure soaker hoses apply cure water uniformly and continuously cover the entire concrete surface without moving the hoses. Prevent excessive localized water discharge. Demonstrate to ENGINEER that soaker hose systems provide uniform coverage of the entire curing surface.
 - d. Place a layer of four (4) mils thick polyethylene film over the entire curing surface and soaker hose system. Overlap seams in the polyethylene at least 10-inches. Activate the system and maintain to ensure complete and uninterrupted wet curing. Control water runoff to prevent hazard to traffic or soil erosion. Do not discharge curing water runoff into surface waters.
 - e. Maintain the wet cure for at least seven days after concrete placement. Do not remove wet cure systems, based on 7-day compressive strengths reached in less than 7 days.
 - f. Use insulating blankets if the forecast air temperature, during the curing period will fall below 45 degrees Fahrenheit. Overlap blankets at least 12 inches. Place the insulating blankets on top of the wet curing system. Leave insulating blankets in place for the duration of the wet curing period.

3.02 Field Quality Control

A. Field Quality Control Testing:

- 1. OWNER will employ a testing laboratory to perform field quality control testing. ENGINEER will direct the number of tests and specimens required. Field quality control testing will be subject to approval by ENGINEER.

2. CONTRACTOR shall make standard compression test specimens as specified below, under the direct inspection by ENGINEER.
3. CONTRACTOR shall furnish necessary assistance required by ENGINEER.
4. CONTRACTOR shall furnish labor, material and equipment required including rods, molds, thermometer, curing in a heated storage box, and other incidentals required. CONTRACTOR shall furnish all necessary storage, curing, and transportation required by the testing.
 - a. Field Tests of Cement Based Grouts and Repair Mortar:
 - (1) Compression test specimens will be taken during construction from the first placement of each type of mortar or grout, and at intervals thereafter as selected by ENGINEER to ensure continued compliance with these specifications. The specimens will be made by ENGINEER or its representative.
 - (2) Compression tests and fabrication of specimens for repair mortar and non-shrink grout will be performed as specified in ASTM C109. A set of three (3) specimens will be made for each test. Tests shall be made at 7 days, 28 days, and additional time periods as appropriate.
 - (3) Material already placed which fails to meet the requirements of these specifications, is subject to removal and replacement at no cost to OWNER.
 - (4) Cost of all laboratory tests on mortar and grout will be incidental to the Work; CONTRACTOR shall obtain specimens for testing at direction of ENGINEER. Any additional tests and investigation on work performed which does not meet the specifications will also be paid for by CONTRACTOR.
 - (5) CONTRACTOR shall supply all materials necessary for fabricating the test specimens.

End of Section

Section 03 4133

Precast Structural Pretensioned Concrete

Part 1 General

1.01 Scope of Work

- A. This Section includes precast and precast prestressed structural concrete as indicated on the Plans complete with product design, manufacture, transportation, erection, and other related items such as anchorage, bearing pads, storage and protection.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200: Unit Prices
- B. Section 03 1500: Concrete Accessories
- C. Section 03 2000: Concrete Reinforcing
- D. Section 04 0511: Mortaring and Grouting

1.03 Reference Standards

- A. Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. AASHTO - American Association of State Highway and Transportation Officials
 - 2. ACI - American Concrete Institute
 - 3. AWS - American Welding Society
 - 4. ASTM - American Society for Testing and Materials
 - 5. PCI - Prestressed Concrete Institute

1.04 Qualifications

- A. Manufacturer shall be a company specializing in providing precast and/or precast prestressed concrete products and services normally associated with the industry for at least five (5) years.
 - 1. When requested by ENGINEER, submit written evidence to show experience, qualifications and adequacy of plant capability and facilities for performance of Contract requirements.
- B. Erector shall be regularly engaged for at least five (5) years in the erection of precast structural concrete similar to the requirements of this Project.
- C. Welders shall have qualified within the past year in accordance with AWS D1.1.

1.05 Design Criteria

- A. Submit design calculations by a registered professional engineer, registered in the state where the Work is located, experienced in precast, prestressed concrete design.
- B. Use in the design, applicable codes, ACI 318, or AASHTO Standard Specifications for Highway Bridges.
- C. Include in the design loads: all dead and live loads as indicated on the Plans, initial handling and erection stresses, and all other loads specified for members where they are applicable.

- D. Watertight Precast reinforced concrete structures shall be designed in accordance with ASTM C890, for A-16 (HS20) loading and installation conditions.

1.06 Reference Specifications

- A. Local codes plus the following Specifications, standards and codes are a part of these Specifications:
 - 1. ACI 318 - Building Code Requirements for Reinforced Concrete.
 - 2. AWS D1.1 - Structural Welding Code.
 - 3. AWS D1.4 - Reinforcing Steel Welding Code.
 - 4. AASHTO Standard Specifications for Highway Bridges.

1.07 Allowable Tolerances

- A. Design deviations may be permitted only after ENGINEER's review of the manufacturer's proposed design supported by complete design calculations and drawings.
- B. Provide an installation equivalent to the basic intent of the Work without incurring additional cost to OWNER.
- C. Length: $\pm 1/8$ inch per 10 feet (1 mm per meter), $\pm 1/4$ -inch (5 mm) maximum
- D. Cross sectional dimensions:
 - 1. Less than 24 inches (600 mm): $\pm 1/4$ inch, (5 mm)
 - 2. 24 to 36 inches (600 to 900 mm): $\pm 3/8$ inch (9 mm)
 - 3. Over 36 inches (900 mm): $\pm 1/2$ inch (10 mm)
- E. Thickness: $\pm 1/4$ inch (5 mm)
- F. Position of anchors and inserts: $\pm 1/2$ inch (10 mm) of centerline location shown on the Plans.
- G. Horizontal alignment or sweep: $1/4$ -inch (5 mm) total or $1/8$ inch per 10-foot length (1 mm per meter), whichever is greater. Maximum of $1/2$ inch (10 mm) gap between two (2) adjacent members due to sweep.
- H. End squareness: $3/8$ -inch (9 mm) maximum
- I. Blockouts: $\pm 1/2$ inch (10 mm) off centerline locations shown on the Plans.
- J. Out of square: $1/8$ inch per six (6) feet (5 mm per 3 m) measured on the diagonal.
- K. Warpage, after installation: $1/8$ inch per 6-foot (5 mm per 3 m) length, or $3/8$ inch (9 mm), whichever is greater.
- L. Vertical alignment:
 - 1. Bottom edges of members from line established at lower face: $\pm 1/4$ inch (5 mm).
 - 2. Bottom surface from straight line between supports: $1/240$ of clear span.

1.08 Source Quality Control

- A. Comply generally with applicable provisions of Prestressed Concrete Institute MNL-116, Manual for Quality Control for Plants and Production of Precast, Prestressed Concrete Products.

1.09 Submittals

- A. CONTRACTOR shall submit design calculations of products not completed and/or indicated on the Plans in accordance with the provisions of Article 1.05 of this Section.
- B. Submit erection or production drawings showing:
 - 1. Drawings/ elevations locating and defining material furnished by manufacturer.
 - 2. Sections/details showing connections, cast-in items and relation to the structure.
 - 3. Description of loose, cast-in and field hardware.
 - 4. Field installed anchor location drawings.
 - 5. Erection sequences and handling requirements.
 - 6. Elevation view of each member.
 - 7. Sections/details to indicate quantities and position of steel, anchors, inserts, etc.
 - 8. Lifting and erection inserts.
 - 9. Dimensions and finishes.
 - 10. Prestress for strand and concrete strengths.
 - 11. Estimated cambers.
 - 12. Method of transportation.
- C. Submit test certificates identifying chemical and physical analysis of materials used for fabrication and physical analysis of the precast product.

1.10 Delivery and Handling

- A. Perform transportation, site handling, and erection with acceptable equipment, methods, and by qualified personnel.

1.11 Storage

- A. Store all units off ground.
- B. Place stored units so that identification marks are easily discernible.
- C. Separate stacked members by battens across full width of each bearing point.
- D. Stack so that lifting devices are accessible and undamaged.
- E. Do not use upper member of stacked tier as storage area for shorter member or heavy equipment.

1.12 Site Access

- A. Provide suitable access to the building and firm level bearing for the hauling and erection equipment to operate under its own power.

Part 2 Products

2.01 Portland Cement

- A. Shall be Type I or Type III: ASTM C150.

2.02 Aggregates

- A. Lightweight aggregates for concrete: ASTM C330.
- B. Fine and coarse aggregate, other than lightweight aggregate: ASTM C33.

2.03 Admixtures

- A. Air-entraining admixtures: ASTM C260.
- B. Water reducing, retarding, accelerating admixtures: ASTM C494.

2.04 Water

- A. Potable or free from foreign materials in amounts harmful to concrete and embedded steel.

2.05 Reinforcing Steel

- A. Reinforcing bars and wire fabric: Per Section 03 2000, Concrete Reinforcing.
- B. Strand Wire or low relaxation strands: Grade 270K, conforming to uncoated 7-wire stress-relieved strand for prestressed concrete: ASTM A416.

2.06 Grout

- A. Grout: Per Section 04 0511, Mortaring and Grouting and complying with the following:
 - 1. Cement Grout: One (1) part Portland cement, 2-1/2 parts sand, sufficient water for placement and hydration.
 - 2. Nonshrink Grout: Premixed, packaged nonstaining, nonshrink grout.

2.07 Bearing Pads

- A. Use bearing pads of the type recommended by the manufacturer where indicated on the plans.

2.08 Welded Studs

- A. Shall be in accordance with AWS D1.1.

2.09 Caulking

- A. Shall be a non-staining 1-part polymer acrylic base sealant.

2.10 Concrete Mixes

- A. Precast, Prestressed:

1. Mixture and mixing of concrete shall be in accordance with ACI 304. The mixture shall produce concrete with the 28-day compressive strength no less than 5,000 psi (34.4 MPa). The strength at initial prestress or form release shall be no less than 3,500 psi (24 MPa). Use of calcium chloride, chloride ions or other salts is not permitted.
- B. Precast:
 1. Shall be the same requirements of precast, prestressed, except the mixture shall produce concrete with the 28-day compressive strength no less than 4,000 psi (27.5 MPa).

2.11 Fabrication and Manufacture

- A. Fabrication and manufacture of precast and/or prestressed products shall comply with the PCI Manual of Practice, and as specified herein.
- B. Provide for those openings ten (10) inches (250 mm) round or square or larger as shown on the Plans. Other openings may be located and field drilled or cut after the precast prestressed products have been erected. Openings shall be approved by ENGINEER before drilling or cutting. No tension reinforcement shall be cut.
- C. Patching will be acceptable providing the structural adequacy of the product and the appearance are not impaired.
- D. Manufacturer shall cast in structural inserts, bolts and plates as detailed or required by the Plans or shop drawings.
- E. No imperfections, honeycomb, or other defects shall be permitted. Provide smooth and dense surfaces, free of voids and projections.
- F. Strands shall be recessed 1-inch (25 mm) and holes grouted. The ends of the member shall receive a smooth finish.
- G. Fabricate precast reinforced concrete structures in accordance with ASTM C913, to the dimensions indicated on the plans, and the specified design criteria.

2.12 Acceptable Manufacturers

- A. Precast concrete decks shall be as manufactured by Price Brothers Company; Concrete Components, Inc.; Precast/ Schokbeton; or equal.
- B. Precast concrete steps shall be as manufactured by Unit Step Company; Michigan Precast Concrete; or equal.

Part 3 Execution

3.01 Contractor's Verification

- A. Examine the substrates and conditions under which the precast concrete is to be installed and notify CONTRACTOR in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 Preparation

- A. Providing true, level bearing surfaces on all field placed bearing walls and other field placed supporting members.
- B. Place and accurately align anchor bolts, plates or dowels in column footings, grade beams and other field placed supporting members.
- C. Shoring required for composite beams and slabs shall conform to all applicable building codes.

3.03 Installation - General

- A. Installation of precast prestressed concrete shall be performed by the manufacturer or a competent erector subcontracted by CONTRACTOR. Members shall be lifted by means of suitable lifting devices at points provided by the manufacturer. Temporary shoring and bracing, if necessary, shall comply with manufacturer's recommendations.

3.04 Alignment

- A. Members shall be properly aligned and leveled as required by the Shop Drawings. Variations between adjacent members shall be reasonably leveled out by jacking, loading, or any other feasible method as recommended by the manufacturer and acceptable to ENGINEER.

3.05 Field Welding

- A. Field welding is to be done by qualified welders using equipment and materials compatible to the base material.

3.06 Grouting and Caulking

- A. After installation of precast units are complete, joints shall be grouted and/or caulked as indicated on the Plans or determined by ENGINEER. Joints shall be completely filled with grout. Any grout which seeps through joints shall be removed and surfaces cleaned before the grout hardens.
- B. Caulking shall be used at all underside joints between members and along bearing walls or beams. Concurrently with the caulking and grouting operation, any chipped or damaged sections or areas adjacent to openings or otherwise imperfect surfaces shall be carefully patched to match the precast surface.

3.07 Attachments

- A. Subject to the approval of ENGINEER, precast prestressed products may be drilled or shot, provided no contact is made with the prestressing steel.

3.08 Field Quality Control

- A. Final inspection and acceptance of erected precast and precast prestressed concrete shall be made by ENGINEER to verify conformance with Plans and Specifications.

3.09 Schedules

- A. Precast product quantity, location, surface finish and dimensions shall be as indicated on the Plans.

End of Section

Division 04
Masonry

Section 04 0511

Mortar and Masonry Grout

Part 1 General

1.01 Section Includes

- A. Mortar and grout for masonry.

1.02 Related Sections

- A. Section 01 3300: Submittal Procedures
- B. Section 01 4500: Quality Control
- C. Section 01 6000: Product Requirements
- D. Section 04 3000: Unit Masonry System
- E. Section 08 1119.13: Stainless Steel Doors and Frames

1.03 References

- A. ACI 530 - Building Code Requirements for Masonry Structures.
- B. ACI 530.1 - 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.
- 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.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- 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.

1.05 Quality Assurance

- A. Perform Work in accordance with ACI 530 and ACI 530.1.
- B. Maintain one copy of each document on site.

1.06 Delivery, Storage, And Handling

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 6000, Product Requirements.
- B. Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.

1.07 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 Fahrenheit (32 degrees Celsius) 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.

Part 2 Products

2.01 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.

2.02 Admixtures

- A. No admixtures shall be used without the expressed written approval of ENGINEER.
- B. It is not the intent of ENGINEER to allow the use of admixtures.

2.03 Mortar Mixes

- A. Mortar for Load Bearing Walls and Partitions: ASTM C270 & C476, Type S for Below Grade Locations and Type N for All Other Locations, using the Proportion specification.
- B. Mortar for Non-Load Bearing Walls and Partitions: ASTM C270 & C476, Type N using the Proportion specification.
- C. Integral Water Repellent: Provide water repellent additive by the same manufacturer for mortar and CMU systems containing integral water repellent admixture
 - 1. Refer to Section 04 3000, Unit Masonry System, for additional requirements and coordination.

2.04 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 Fahrenheit (32 degrees Celsius), or two-and-one-half hours at temperatures under 50 degrees Fahrenheit (10 degrees Celsius).

2.05 Grout Mixes

- A. Bond Beams, Lintels and other areas that may be called for on the Drawings: 3,000 psi (21 MPa) strength at 28 days; 8-10 inches (200-250 mm) slump; mixed in accordance with ASTM C476, fine grout.

2.06 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.

2.07 Mix Tests

- A. Test mortar and grout in accordance with Section 01 4500, Quality Control.
- 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.

2.08 Repointing

- A. Deteriorated mortar joints in existing Building masonry, and other areas that may be shown on the Contract Drawings, shall be cleaned out and refilled with fresh mortar.
- B. 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. Refer to quantities shown on Contract Drawings.
- D. Raking 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. 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.
 - 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 4-1/2 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 as It does not flow to the bottom of the joint after it has been pushed into the joint with a 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 2-1/2 hours after they are mixed.
- 6. Colored mortars shall not be retempered.

Part 3 Execution

3.01 Examination

- A. Request inspection of spaces to be grouted.

3.02 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 re-tempered as required to maintain consistency. Dispose offsite 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 mismatch.
- 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.

3.03 Field Quality Control

- A. Field inspection and testing will be performed in accordance with the Structural Tests and Special Inspections in the Michigan Building Code, refer to Table 1705.4.
- B. Test and evaluate mortar in accordance with ASTM C780.
- C. Test and evaluate grout in accordance with ASTM C1019.

End of Section

Section 04 2200 Unit Masonry

Part 1 General

1.01 Section Includes

- A. Replacement Face brick.
- B. Concrete masonry units (CMU).
- C. Reinforcement, anchorage, and accessories.

1.02 Products Installed but Not Furnished Under This Section

- A. Section 04 0511: Mortar and Masonry Grout
- B. Section 05 1200: Structural Steel Framing
- C. Section 05 0500: Metal Fabrications
- D. Section 07 6200: Sheet Metal Flashing and Trim
- E. Section 07 9200: Joint Sealants
- F. Section 08 1226: Custom Steel Frames
- G. Section 08 5123: Steel Windows

1.03 References

- A. ACI 530 - Building Code Requirements for Masonry Structures.
- B. ACI 530.1 - 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 C126 - Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units.
- M. ASTM C129 - Non-Load Bearing Concrete Masonry Units.
- N. ASTM C652 Hollow Brick (Hollow Masonry Units Made From Clay or Shale).
- O. IMIAC - International Masonry Industry All-Weather Council: Recommended Practices and Guide Specification for Cold Weather Masonry Construction.
- P. UL - Fire Resistance Directory.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Product Data: Provide data for masonry units and fabricated wire reinforcement.
- C. Product Data: Provide data for masonry accessories, cleaning solution, 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.

1.05 Quality Assurance

- A. Perform Work in accordance with ACI 530 and ACI 530.1.
- 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.

1.06 Qualifications

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.07 Pre-Installation Conference

- A. Convene one week prior to commencing work of this section, under provisions of Section 01 3119, Project Meetings.

1.08 Delivery, Storage, And Handling

- A. Deliver, store, protect and handle products to site under provisions of Section 01 6000, Product Requirements.

1.09 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 Fahrenheit (32 degrees Celsius) prior to, during, and 48 hours after completion of masonry work.

1.10 Coordination

- A. Coordinate work under provisions of Section 01 3119.
- B. Coordinate the masonry work with Rough Stone veneer, installation of door frames and window anchors.

Part 2 Products

2.01 Face Brick

- A. Face brick shall be ASTM C216 – color, texture, module, finish and size to match existing beige brick at Influent Building. Provide sample board for OWNER review and approval.

2.02 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. Color for integrally colored units used in the building(s) shall be synthetic iron oxide, dry granulated pigments. Color shall be selected by OWNER from the manufacturers complete color palette.
- C. Hollow Load Bearing Block Units (CMU): medium weight, ASTM C-90.
- D. Solid Load-Bearing Block Units (CMU): medium weight, ASTM C-90.
- E. Integrally Colored Smooth Faced Size and Shape: Nominal modular size of 8 x 16 x thickness shown having a smooth face on one side of masonry block as shown on Drawings. Provide special units for 90-degree corners, bond beams, lintels, and bullnosed corners. CMU is to be integrally colored; intent is to match the color/texture of the existing beige brick at adjacent buildings as closely as possible.
 - 1. Colors for the project will be selected by OWNER from the block manufacturer's palette of all colors available for the specific block during the shop drawing approval process.
- F. 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.
- G. CMU Admixture System for Single Wythe CMU Exterior Walls:
 - 1. Admixture shall consist of two polymeric admixtures.
 - a. One, covered by this short-form specification, is mixed throughout the low slump concrete during manufacture of the CMU by a Qualified CMU manufacturer.
 - b. The second admixture is added to the mortar on site, during mixing, by the mason.
 - 2. Both admixtures are necessary to achieve a water-repellent single wythe CMU wall.
 - 3. This admixture combination is only required for exterior single wythe CMU walls exposed to the weather.
 - 4. Admixtures shall be as manufactured by Krete Industries, W.R. Grace Chemicals or other approved.

2.03 CMU Insulating System

- A. All CMU shall be insulated, except where solid or grout filled block are called for on the Drawings.

- B. Insulation shall be Polymaster R-501 foamed in-place insulation (www.polymaster.com) or other Engineer approved foamed in-place product with the same R value.
 - 1. Product shall be a 3-part polymer foamed in-place plastic insulation with a powder resin mixed with a catalyst and foamed with nitrogen or compressed air.
 - 2. R value per inch thickness of the insulation shall be 4.6.
 - 3. Surface burning characteristics shall meet ASTM E-84 with a flamespread of 25 and smoke developed of 50.
 - 4. Building Code surface burning classification Class 1 or Class A.

2.04 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.
- B. Approved Manufacturers:
 - 1. A-A Wire Products
 - 2. Dur-O-Wal, Inc.
 - 3. Hohmann & Barnard, Inc.

2.05 Mortar and Grout

- A. Mortar and Grout: As specified in Section 04 0511, Mortar and Masonry Grout.

2.06 Flashings

- A. Base Flashing at Single Wythe Exterior Walls:
 - 1. BlockFlash" pan flashing with adjoining bridge, integral weeps (with bug guards) and drainage mats manufactured by Mortar Net Solutions.
 - 2. Install at wall base above grouted core row and above wall opening lintels.
- B. 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).
- C. Approved Manufacturers:
 - 1. Dur-O-Wall, Inc., Dur-O-Barrier.
 - 2. W.R. Grace & Co., Construction Products Division, Perm-A-Barrier Wall Flashing.
 - 3. Hohmann & Barnard, Inc., Textroflash.
 - 4. Polyguard Products, Inc. Polyguard 300.
 - 5. Williams Products, Inc., Everlastic MF-40.
- D. 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".

2.07 Accessories

- A. Joint Filler (Backer Rod): Refer to Specification Section 07 9200, Joint Sealants.
- B. Nailing Strips: Softwood, preservative treated for moisture resistance, dovetail shape, sized to masonry joints.
- C. 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.
- D. Control Joint Filler: 3/8-inch thick, 3-inch wide, closed cell neoprene strip gasket. Use two (2) 3-inch strips at CMU wall, for installed width of 6 inches.
- E. 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.

Part 3 Execution

3.01 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 ENGINEER and OWNER 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 CONTRACTOR and OWNER without additional cost to OWNER.
 - 4. Steel Frame discrepancies affecting the masonry work shall be resolved by CONTRACTOR and OWNER without additional cost to OWNER.
- 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. 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.

3.02 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.

3.03 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.
 - 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.
- G. Door jambs and other exposed corners shall be manufactured bullnosed block. Unless otherwise shown on the Contract Drawings, grinding block in the field shall not be acceptable.

3.04 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:

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.

1. Provide the last course in such walls or partitions of solid units terminating to provide 3/8-inch space minimum.
- F. Buttering corners of joints or excessive furrowing of mortar joints are not permitted.
- G. Remove excess mortar as work progresses.
- H. 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 wall units.
 4. Precautions shall be taken to avoid staining of the finished surface of the masonry units.
- I. Interlock intersections and external corners. The intersection of all walls shall be toothed together with the intersecting wall.
- J. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- K. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
- L. 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.
- M. 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.
- N. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.
- O. 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.
- P. Fill the spaces between metal frames and masonry with grout.
- Q. Use cores filled with mortar or provide solid units for anchorage in locations where handrails, plumbing fixtures, utility cabinets and similar items are attached.
- R. 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 OWNER's Representative before proceeding.
- S. Masonry work that shows evidence of having been frozen shall be removed and replaced new materials.
- T. Masonry work shall never be placed on snow or ice-covered surfaces. Surfaces shall be cleaned and dried prior to proceeding with the new masonry work.
- U. Wet or frozen masonry units shall not be used until they are allowed dry.

- V. 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.

3.05 Reinforcement and Anchorage – Single Wythe Masonry

- A. Install horizontal joint reinforcement 16-inches (400 mm) oc.
- B. Lap joint reinforcement ends minimum 6-inches (150 mm).
- C. Install prefabricated corners and tees.
- D. Support and secure reinforcing bars from displacement. Maintain position within 1/2-inch (13 mm) of dimensioned position.
- E. 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.

3.06 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. Lap end joints minimum 6-inches (150 mm) and seal watertight.
- D. Turn flashing, fold, and seal at corners, bends, and interruptions.

3.07 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.

3.08 Grouted Components

- A. Place horizontal mortar mesh over cores below grouted course(s).
- B. Reinforce bond beam with 4, No. 5 bars, 1 inch from top or bottom web unless noted otherwise on the Drawings.
- C. Support and secure reinforcing bars from displacement. Maintain position within 1/2-inch (13 mm) of dimensioned position.
- D. Place and consolidate grout fill without displacing reinforcing.
- E. At bearing locations, fill masonry cores with grout for a minimum 12 inches (300 mm) either side of opening.
- F. 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.

3.09 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 Contract Drawings and in accordance with Section 07 9200, Joint Sealants, 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.
 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.

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.

3.10 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.

3.11 CMU Insulation Installation

- A. Handle and store products in accordance with manufacturer's published recommendations.
- B. Drill the 5/8" foam injection holes in the least conspicuous places.
 1. Holes shall be centered on the mortar joints.
 2. For the majority of the hole locations, use the mortar joint at the intersection of a vertical and horizontal mortar joint.
 3. It is anticipated that there will need to be 1 set of foam insulation injection holes located approximately 7'-4" above the finished floor.
 4. If more than 1 set of injection holes are required vertically, consult with ENGINEER prior to drilling additional holes.
- C. Install foam in CMU cores to a uniform density.
- D. Completely fill all spaces, crevices and voids.
 1. Verify density of foam in-place insulation by filling a 1-gallon open top bag. When foam is cured bag shall weigh between 285 and 325 grams.
 2. Drill a minimum of 10 holes in locations requested by ENGINEER to verify complete filling of the masonry wall cores.
 3. If deficiencies are found, additional holes shall be drilled until ENGINEER is satisfied that all problems have been located.
 4. Correct any deficiencies found during the inspection.
 5. Repair inspection holes.

- E. Repair foam injection and inspection holes by cleaning to the full depth of the original mortar and filling with fresh mortar finished to the profile and texture of the original mortar. Mortar colors shall match.
- F. Do not install foamed in-place insulation if air temperatures are below 50 degrees Fahrenheit or expected to fall below 50 degrees Fahrenheit during the 12 hours after installation.

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 feet and 1/2-inch in 20 feet or more.
- D. Maximum Variation from Plumb: 1/4-inch per story non-cumulative; 1/2-inch in two (2) stories or more.
- E. Maximum Variation from Level Coursing: 1/8-inch in 3 feet and 1/4-inch in 10 feet; 1/2-inch in 30 feet.
- F. Maximum Variation of Joint Thickness: 1/8-inch in 3 feet.
- 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 feet and 1/4-inch in 8 feet.

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 01 4500, Quality Control.
- B. Field Inspections / Quality Assurance:
 - 1. Special masonry inspections shall not be required for empirically designed masonry that is part of non-essential buildings as defined by the MBC.

3.15 Cleaning

- A. Clean work under provisions of 01 7700, Closeout Procedures.
- B. Protect surfaces that could be harmed by cleaning operations.
- C. 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.
- D. 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.
- E. 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.
- 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 ENGINEER prior to starting the work.
 - a. CONTRACTOR shall start with the mildest cleaning solution available and work to the stronger cleaning agents if the stains persist.
 - b. 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.
 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 OWNER and ENGINEER's intention to have a uniform appearance in the final wall surfaces.
- H. Remove excess materials, debris, equipment, sample panels, etc. from site upon completion and acceptance of masonry work.
- I. Use non-metallic tools in cleaning operations.

3.16 Protection of Finished Work

- A. Protect finished Work under provisions of Section 01 5000, Temporary Facilities and Controls.

- B. 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 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 OWNER, CONTRACTOR shall clean the walls again, in accordance with the above specified procedures, to make them acceptable.

End of Section

Section 04 2300 Glass Unit Masonry

Part 1 General

1.01 Section Includes

- A. Mortar bed and pointing sealant.
- B. Perimeter treatment.

1.02 Related Sections

- A. Section 04 0511: Mortar and Masonry Grout
- A. Section 04 2200: Unit Masonry System
- B. Section 07 9200: Joint Sealants

1.03 References

- A. ASTM A 82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement; 2001.
- B. ASTM A123 - Zinc (Hot-Galvanized) Coatings of Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips.
- C. ASTM A 153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2001a.
- D. ASTM C270 - Mortar for Unit Masonry.
- E. ASTM C780 - Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
- F. ASTM D 1187 - Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal; 1997 (Re-approved 2002).
- G. ASTM D 1227 - Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing; 1995 (Re-approved 2000).
- H. IMIAC - International Masonry Industry All-Weather Council: Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.
- I. IMIAC - International Masonry Industry All-Weather Council: Recommended Practices and Guide Specifications for Hot Weather Masonry Construction.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Product Data: Provide data for glass units and accessories.
- C. Samples:
 - 1. Submit two glass units illustrating size variations, color, design, and face pattern.

- 2. Submit representative samples of panel reinforcing, panel anchors, expansion strips and sealant as required by the project.
- D. Submit documentation verifying that glass block units are classified for a ¾-hour fire exposure according to ASTM E163 or UL 9 Fire Test of Window Assemblies. All such glass block units shall carry the appropriate UL Labels.
- E. Manufacturer's Installation Instructions: Indicate special procedures, positioning of reinforcement, perimeter conditions requiring special attention, and any other special instructions.

1.05 Qualifications

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 3 years' experience.
- B. Installer: Company specializing in performing the work of this section with minimum 3 years' experience.

1.06 Delivery, Storage and Handling

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 6000, Product Requirements.
- B. Store products in manufacturer's unopened packaging in a clean, cool, dry area until ready for installation.
- C. Protect opened cartons of glass block against windblown rain or water runoff with tarpaulins or plastic coverings.
- D. Accept glass units on site on pallets; inspect for damage.

1.07 Environmental Requirements

- A. Do not install glass block when temperature is 40 degrees Fahrenheit (4 degrees Celsius) and falling.
- B. Cold Weather Requirements: IMIAC - Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.
- C. Hot Weather Requirements: IMIAC - Recommended Practices and Guide Specifications for Hot Weather Masonry Construction.

1.08 Field Measurements

- A. Verify that field measurements on shop drawings.

1.09 Extra Materials

- A. Provide ten of each type and size of glass unit.

Part 2 Products

2.01 Manufacturers - Glass Units

- A. Pittsburgh Corning.
- B. Substitutions: Under provisions of Section 01 2513, Substitution Procedures.

2.02 Glass Units

- A. Hollow Glass Units shall be partially evacuated units made of clear glass.
 - 1. Nominal Size: As noted on Drawings
 - 2. Color: Clear, colorless glass.
 - 3. Pattern and Design: Decora, Premier Series
 - 4. Insulation Value: U value of .51 BTU/sq ft/h/degree Fahrenheit
 - 5. Compressive Strength: 400-600 psi
 - 6. Visible Light Transmittance: 75 percent
 - 7. Shading Coefficient: 0.65
 - 8. Impact Strength: 50 to 60 pounds
 - 9. Sound Transmission, STC: 39
 - 10. Edge: with polyvinyl butyral coating

2.03 Accessories

- A. Panel Reinforcement: Shall be Stainless Steel:
 - 1. Side Rods: Two 9 gage (4 mm) rods spaced 2 inches (50 mm) apart.
 - 2. Cross Rods: 14 gage (1.8 mm) rods welded 8 inches (200 mm) oc.
- B. Expansion Strips: Dense glass fiber matting, 7/16 x 4 inches (11 x 100 mm) nominal size.
- C. Perimeter Channel: Stainless Steel channel and angles, size, as detailed on the drawings, one piece per edge length installed.
- D. Asphalt Emulsion: Water based, similar to Karnac Chemical Corp., Karnac 100.
- E. Backing Rods: polyethylene foam, neoprene, fibrous glass, or equal as approved by the sealant manufacturer.

2.04 Mortar and Pointing Material

- A. Mortar: Type S in accordance with ASTM C270. Mortar shall be 1/2-part Portland Cement, 1/2-part lime, and sand equal to 2-1/4 to 3 times the amount of cementitious material (cement plus lime), all measured by volume.
 - 1. Portland Cement: Type 1 in accordance with ASTM C150.
 - 2. Lime: Type S in accordance with ASTM C207. Shall be a high calcium lime, or a pressure hydrated dolomitic lime, provided that not less than 92% of all active ingredients are hydrated.
 - 3. Sand: A clean white quartzite or silica type, essentially free of iron compounds, for thin joints, in accordance with ASTM C144, not less than 100% passing a No. 8 sieve.
- B. Pointing Sealant: Shall be as specified in Section 07 9000, Joint Sealants.

2.05 Mortar Mixing

- A. Thoroughly mix mortar ingredients in accordance with ASTM C270 in quantities needed for immediate use.
- 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 90 degrees Fahrenheit (32 degrees Celsius), or two-and-one-half hours at temperatures under 50 degrees Fahrenheit (10 degrees Celsius).

2.06 Mix Tests

- A. Testing of Mortar Mix: In accordance with ASTM C270.

Part 3 Execution

3.01 Examination

- A. Verify that openings are ready to receive work.
- B. Field Measure openings to verify size.

3.02 Preparation

- A. Clean glass units of substances that may impair bond with mortar or sealant.
- B. Establish and protect lines, levels, and coursing.
- C. Protect elements surrounding the work of this section from damage or disfiguration.

3.03 Installation

- A. Erect glass units and accessories in accordance with manufacturer's printed instructions.
- B. Verify that the channels have been provided at the head and jambs for the purpose of providing panel support within the opening.
- C. Mix all mortar components to a consistency that is drier than mortar for ordinary masonry construction. Retempering of the mortar after it has taken its initial set shall not be permitted. DO NOT USE ANY ANTI-FREEZE COMPOUNDS OR ACCELERATORS.
- D. Cover sill surface under units with heavy asphalt emulsion as a bond breaker and allow to dry at least 2 hours before first mortar bed is placed.
- E. Adhere expansion strips to the jamb and head. Verify that the expansion strips extend the full length of the joint.
- F. Set a full bed of mortar applied to the sill.
- G. Set the lower course of block. Allow a uniform joint width of 1/4". All mortar joints must be full and not furrowed. Do not use steel tools to tap glass block into position. Do not re-align, tap or otherwise move block after initial placement.
- H. Place panel reinforcement at every second horizontal joint (16" o.c.) in full mortar bed and at first course above and below openings within the glass unit panel.
- I. Run reinforcing continuous for panel width. Lap reinforcement joints 6 inches (150 mm). Discontinue reinforcement at expansion joints.
- J. Isolate panel from adjacent construction on sides and top with expansion strips concealed within perimeter trim. Keep expansion joint voids clear of mortar.
- K. Strike joints smooth while mortar is still plastic and before final set. Remove surplus mortar from the faces of glass block and wipe dry. Tool joints smooth and concave before mortar takes final set. At this time remove and clean out all excess mortar from jamb, head and other locations.

- L. After mortar has taken final set (approximately 24 hours), install packing tightly between glass block panels and jamb and head construction. Leave space for sealant.
- M. Place sealant in mortar joints in accordance with Section 07900. Install sealant evenly to a full depth of recesses as indicated on the Drawings and in accordance with the manufacturer's application manual and instructions.
- N. All glass block panels shall be well sealed to prevent water entry.

3.04 Tolerances

- A. Variation from Joint Width: Plus or minus 1/16 inch (1.6 mm) and minus 0 inches (0 mm).
- B. Maximum Variation from Plane of Unit to Adjacent Unit: 1/32 inch (0.8 mm).
- C. Maximum Variation of Panel from Plane: 1/16 inch (1.6 mm).

3.05 Cleaning

- A. Manufacturers recommendations for cleaning the units shall be followed
- B. Do not scratch or deface units.
- C. Remove surplus mortar from the glass units at the time the joints are struck or tooled. Mortar should be removed while it is still plastic using a clean, wet, sponge.
- D. Do not use harsh cleaners or acids (of any strength), abrasives or alkaline materials when cleaning the glass block. Do not use a wire brush to remove mortar from the face of the glass block.
- E. Final cleaning of the glass block must be done after they are completely installed.. Wait until the panels are not in direct sunlight. Start at the top of the panel and flush with large amounts of clean water. Dry all water from the glass block surface. Change cloth frequently to eliminate dried mortar or small aggregate that could scratch the block.

3.06 Protection of Finished Work

- A. Protect finished Work under provisions of Section 01 6000, Product Requirements.
- B. Maintain temperature of glass unit masonry above 40 degrees Fahrenheit (4 degrees Celsius) for the first 48 hours after construction
- C. Maintain protective boards at exposed external corners. Provide protection without damaging completed work.
- D. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

Division 05
Metals

Section 05 5000 Metal Fabrications

Part 1 General

1.01 Section Includes

- A. This Section includes shop fabricated steel and aluminum items as indicated on the Plans complete with materials, fabrication and installation.

1.02 Related Work Specified Elsewhere

- A. Section 03 1500: Concrete Accessories
- B. Section 03 3000: Cast-in-Place Concrete

1.03 Reference Standards

- A. Unless otherwise specified, the Work of this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. AISC – American Institute of Steel Construction
 - 2. ASTM – American Society of Testing and Materials
 - 3. FS – Federal Specifications
 - 4. OSHA – Occupational Safety and Health Act

1.04 Design Criteria

- A. Grating, railings, stairs and hatches shall be capable of supporting loads as indicated unless otherwise shown on the Plans.
- B. Top rail and supports of Guardrail System:
 - 1. Concentrated load of 200 lbs. (90 kg) applied at any point in any direction.
 - 2. Uniform load of 50 pounds per linear foot (75 kg/m) applied to the top rail horizontally with a simultaneous load of 100 lbs. per linear foot (150 kg/m) applied vertically downward.
- C. Handrail not serving as top rails:
 - 1. Horizontal concentrated load of 200 lbs. (90 kg) applied at any point.
 - 2. Uniform load of 50 pounds per linear foot (75 kg/m) applied at any point.
 - 3. Concentrated and uniform loads need not be assumed to act concurrently.
- D. Intermediate rails (all those except handrails), balusters and panel fillers:
 - 1. Horizontal applied normal load of 50 pounds (220 N) on an area not to exceed 1 square foot (925 cm²) including openings and space between rails. Reactions due to this loading are not required to be superimposed with those of preceding paragraphs.
- E. Gratings, hatches and stairs:

1. Uniformly distributed load of 200 lbs per square foot (975 kg/m²) of horizontal surface.
 2. Maximum allowable deflection is 1/4 inch (5 mm) with 150 pounds per square foot (730 kg/m²) uniformly distributed load or 500 pounds (225 kg) concentrated load applied at mid-span.
- F. Stairway and ladder design shall conform to the latest Michigan OSHA requirements for loading, rail sizes, and dimensions.

1.05 Requirements of Regulatory Agencies

- A. The latest Federal OSHA Standards, as adopted by the State of Michigan, and as they relate to floor and wall openings, grating, stairways, ladders and skylights, shall apply to the Work of this specification where applicable.
- B. Expansion anchor bolts shall meet OSHA requirements for pull out and shear.

1.06 Quality Assurance

- A. Manufacturer's Qualifications:
1. Design connections and components not detailed on drawings under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State of Michigan.
- B. Inspection:
1. Work done in accordance with this specification shall be subject to inspection. OWNER/ENGINEER shall have access to all places of manufacture where materials are being produced or fabricated, or where tests are being conducted and shall be accorded full facilities for inspection and observation.

1.07 Submittals

- A. Submit shop drawings showing layout, fabrication dimensions, anchoring details and erection information for stair nosings, ladders, grating and floor hatches. Include pull-out and shear-strength information for recommended anchor bolts.
- B. Fabrication and/or erection of items done prior to ENGINEER review of shop drawing shall be at the risk and expense of CONTRACTOR.
- C. When requested by ENGINEER, submit mill or laboratory certified copies of testing reporting chemical analysis and physical property of metal used in fabrication of items of this Section.
- D. Submit affidavits when requested by ENGINEER, certifying that the grating, handrail, and ladder capacities comply with the requirements as specified and indicated in this Section or on the Plans.
- E. Certification that the equipment meets OSHA 1910.27 standard for Climber Protection shall be submitted.

1.08 Product Delivery, Storage, and Handling

- A. Deliver miscellaneous metal items in an undamaged condition. Damaged items shall be repaired or replaced to the satisfaction of OWNER at the expense of CONTRACTOR.
- B. Store items to permit easy access for inspection and identification. Keep items off the ground, using pallets, platforms, or other supports. Protect unpackaged and packaged items from erosion and deterioration of shop paint or finish surface.
- C. Do not store on the structure in a manner that might cause distortion or damage to the members of the supporting structures. Repair or replacement shall be to the satisfaction of OWNER at the expense of CONTRACTOR.

1.09 Protection

- A. Installed anchor bolts, inserts and other miscellaneous metal items shall be protected while other Work is being performed. Installed items that are damaged shall be repaired or replaced at CONTRACTOR's expense.

1.10 Sequencing

- A. Anchors, frames, or other miscellaneous metal items to be embedded in concrete shall be provided on site as required for uninterrupted construction sequence.

1.11 Guarantee

- A. Floor hatches shall bear the manufacturer's 5-year guarantee for proper operation and against defects in materials and workmanship.

Part 2 Products

2.01 Zinc Coating

- A. Unless otherwise indicated on the Plans or specified herein, miscellaneous metals shall receive zinc coatings as follows:
 - 1. Steel Shapes, Plates or Bars: ASTM A123
 - 2. Hardware of Steel or Iron: ASTM A153
 - 3. Assembled Steel Products: ASTM A123

2.02 Plates, Sheets, Shapes and Bars

- A. Steel: ASTM A36
- B. Aluminum:
 - 1. Plate and Sheet: Alloy 6061, Temper T6, ASTM B209
 - 2. Extruded Shapes and Bars: Alloy 6061 T6, ASTM B221
- C. Stainless steel: ASTM A316

2.03 Tubing

- A. Steel:

1. Hot Formed Welded or Seamless Rolled: ASTM A501A1011, Grade 50
2. Cold Finished: Formed, ASTM A512A500, Grade C
3. Aluminum: Alloy 6061 T6, ASTM B221

2.04 Pipe

- A. Steel: Black finish unless otherwise specified, Type E or S, Grade B, Schedule 40, ASTM A53
- B. Aluminum: Alloy 6061 T6, ASTM B429

2.05 Expansion Anchor Bolts

- A. Expansion anchor bolts shall be furnished and installed in accordance with Section 03 1500, Concrete Accessories.

2.06 Grating and Stair Treads

- A. Steel:
 1. Minimum 3/16 inch (4 mm) thick bearing bars manufactured from USS "Cor Ten" Steel with Blaw Knox Ponbake, Bordon Bo Ly, or approved equal finish. Stair treads shall have minimum 1 inch (25 mm) wide diamond plate nosings.
- B. Aluminum:
 1. Standard rectangular bar manufactured from Alloy 6061 T6, ASTM B221 with standard finish. Stair treads shall have abrasive nosings.

2.07 Concrete Stair Nosing

- A. Ferrous metal tread nosing with abrasive tread surface. Nosing shall be minimum 1/8-inch thick, shall have a minimum of 4-inch legs on the horizontal surface of the tread and 2-inch leg on the vertical surface of the riser, and shall extend the full width of the tread. Nosing shall be integral with the concrete stairs by steel studs or anchors. Nosing shall be painted with an approved epoxy paint system.

2.08 Railings

- A. Pipe railing system shall consist of top and intermediate rail with posts and kickplates. Handrail system for stairs shall consist of top and intermediate rail, and posts.
- B. Aluminum rail and posts shall be nominal 1-1/2" (40 mm) diameter, Schedule 40. All fittings shall be extruded aluminum, machined to final shape. All fasteners shall be stainless steel. Fabricate railing systems and handrails for connection of members by means of manufacturer's standard concealed mechanical fasteners and fittings unless otherwise approved.
- C. Steel rails and posts shall be minimum 1-1/2" (40 mm) diameter, schedule 40, black steel pipe of flush welded construction.

2.09 Ladders

- A. All items for ladders and associated safety devices shall be manufactured from aluminum alloy as stated above with stainless steel anchor bolt unless otherwise noted on the plans.

2.10 Fabrication

A. General:

1. Miscellaneous steel fabrications shall conform to AISC Code of Standard Practice. Welding where permitted and performed shall be in accordance with AWS Code for Welding in Building Construction.
2. Fabricate items to dimensions on plans or ENGINEER approved shop drawings. Use the type of materials of size and thickness as indicated on the Plans or specified herein. All structural members framing into beams or columns, unless otherwise detailed on the Plans, shall have standard framing connection angles of sufficient strength to develop the full strength of the member, even though the design stress may be less. Connections shall be bolted, welded or other ENGINEER approved means. Exposed connections shall be flush. Grind welds smooth to match and blend with adjoining surfaces.
3. Ferrous metal fabrications not to be galvanized or embedded in concrete shall be coated with a primer as specified in Division 9 of the Technical Specifications or as specified for individual items.

B. Grating and Stair Treads:

1. Grating shall be fabricated with span lengths and panel widths as indicated on the Plans. Bearing and cross bars shall be spaced evenly and provide the required loading capacity. Edges of grating panels shall be solid, flush for the full depth of the grating.

C. Ladders:

1. Ladders shall be fabricated in accordance with the details shown.
2. Ladder climbing safety devices such as cages shall be provided for all ladders 20 feet (6 m) or greater in length.

D. Floor Hatches:

1. Hatches shall be of sizes indicated on the Plans. Frame and door shall be aluminum with stainless steel hinges and pins unless otherwise called for on the plans. Provide spring counter balanced operators, automatic hold open arm with release handle and snap lock with removable handle. Hardware shall be stainless steel unless otherwise noted on the plans. Door shall have diamond checkered pattern.
2. Frames shall be neatly mitered and shall have welded corners and anchors.
3. Aluminum surfaces to come in contact with concrete, wood, and dissimilar metals shall be shop coated with alkali resistant bitumastic paint as specified in Division 9 of the Technical Specifications.

E. Lintels:

1. Steel lintels shall be provided for openings as shown and scheduled. Lintels shall have not less than four (4) inches (100 mm) of bearing on each end and shall have an additional 1 inch (25 mm) of bearing at each end for each 1 foot

(300 mm) of clear span over four (4) feet (1200 mm), unless otherwise shown. Horizontal sections of lintels between the edge of the masonry opening and the end of the lintel shall be coped to allow for masonry joint not less than 1 inch (25 mm) deep measured from the interior and exterior faces of the masonry wall. See Lintel Schedule shown at the end of this Section.

2. Where steel plates are used in connection with structural shapes, they shall be welded to such structural shapes.

F. Guard Chains:

1. Where indicated on the Plans, chains shall be 3/16 inch (4 mm) cadmium plated steel link construction, provided with snap type fasteners at each end to permit attachment to posts and/or wall eyelets. Two (2) strands of chain, mounted at heights equal to guardrails, shall be installed wherever noted on the Plans.

G. Guard Posts:

1. Guard posts shall be 6 inch (150 mm) diameter, steel pipe conforming to ASTM A53, Schedule 80, filled with concrete. Guard Posts shall be galvanized steel unless otherwise shown on the plans. Guard posts to be painted shall have:
 - a. 2 – 3 mil polyamide epoxy primer
 - b. 2 – 3 mil aliphatic acrylic polyurethane, semi-gloss total dry film thickness 4 – 6 mils

2.11 Acceptable Manufacturers

- A. Acceptable manufacturers of steel grating include: Blaw Knox "Cor Ten" steel with "Ponbake" finish; Gary Bo Ly; or equal.
- B. Acceptable manufacturers of aluminum grating include: Reliance Steel Products Company; Gary Aluminum Grating, manufactured by IKG Industries; or equal.
- C. Acceptable manufacturers of floor hatches include: Babcock Davis Associates, Inc.; Bilco Company; Halliday Products Inc., or equal.

Part 3 Execution

3.01 Installation – General

- A. Miscellaneous metal items shall be installed plumb, level, square and true, set at proper elevations and positioning. Bearing surfaces and surfaces to be in permanent contact shall be cleaned of dirt, rust, and other substances before the members are assembled.
- B. Do not weld, cut or abrade the surfaces of exterior units which have been hot dip galvanized after fabrication, and are intended for bolted or screwed field connections.

3.02 Installation of Anchor Bolts

- A. Drill holes of diameter and depth recommended by anchor manufacturer. Clean hole of dust and debris before inserting anchor. Assemble anchor and complete installation according to manufacturer recommendations.

3.03 Installation of Grating, Floor Hatches, and Stair Nosings

- A. Install items at locations indicated on the Plans in accordance with manufacturer's recommendations. Frames to be embedded in concrete shall be installed flush with the finished floor and shall be carefully leveled so that the plates of gratings do not rock.
- B. Install stair nosings on concrete stairs.
- C. Install eyelets in walls and/or posts for securing guard chains as indicated on the Plans. Mount chain strands at elevations equal to railings.

3.04 Installation of Guard Posts

- A. Guard posts shall be set a minimum of 3' 6" (1 m) below finished grade in a concrete foundation as shown on the Plans. Guard posts shall extend 5' 0" (1.5 m) above finished grade.

3.05 Installation of Railings

- A. Provide pipe railing system with maximum 8-foot (2400 mm) maximum post spacing and minimum 42-inch (1050 mm) railing height to top rail. Top rail of handrailing system shall be 34-inches (865 mm) high as measured from the leading edge of any tread. Provide minimum 3-inch (75 mm) clearance from the wall for single pipe handrail supported on brackets.
- B. Provide removable pipe railings with close-fitting sleeves set in concrete where indicated on the Plans. Sleeves shall be 1-inch (25 mm) less in length than thickness of concrete.

3.06 Steel Lintel Schedule

See Next Page for Steel Lintel Schedule

Wall Thickness	Opening Length	Description (inches and pounds)	Remarks
8"	Up to 3'-6"	2 - 3-1/2"x3-1/2"x5/16"	See Notes Nos. 2 & 3
	3'-6" to 6'-6"	2 - 4"x3-1/2"x5/16"	SLH, See Notes Nos. 2 & 3
	6'-6" to 12'-6"	W8x10 1 - 5/16"x6-1/2" Plate	
12"	Up to 3'-6"	3 - 3-1/2"x3-1/2"x5/16"	See Note No. 3
	3'-6" to 6'-6"	3 - 4"x3-1/2"x5/16"	SLH, See Note No. 3
	6'-6" to 12'-6"	W8 x 18 1 - 5/16"x10-1/2" Plate	
14"	Up to 3'-6"	2 - 3-1/2"x3-1/2"x5/16" 1 - 5"x3-1/2"x5/16"	LLH, See Note No. 3
	3'-6" to 6'-6"	2 - 5"x3-1/2"x5/16" 1 - 5"x5"x5/16"	SLH, See Note No. 3
	6'-6" to 12'-6"	W8x18 1 - 5/16"x12-1/2" Plate	
16"	Up to 3'-6"	3 - 5"x3-1/2"x5/16"	LLH, See Notes Nos. 2 & 3
	3'-6" to 6'-6"	3 - 5"x5"x5/16"	See Notes Nos. 2 & 3
	6'-6" to 12'-6"	W8 x 18 1 - 5/16"x14-1/2" Plate	Provide 1/4" Plate Stiffener, Each Side at 24" O.C.
18"	Up to 3'-6"	W8x10 1 - 5/16"x16-1/2" Plate	
	3'-6" to 6'-6"	W8x13 1 - 5/16"x16-1/2" Plate	Provide 1/4" Plate Stiffener, Each Side at 24" O.C.
	6'-6" to 12'-6"	W8x18 1 - 5/16"x16-1/2" Plate	Provide 1/4" Plate Stiffener, Each Side at 24" O.C.

- NOTES:
1. For openings larger than 12'-6", see Plans for size and shape.
 2. See Specifications for coping requirements.
 3. Provide 5/16" x (Wall Thickness - 1-1/2") Plate, when seam is exposed to view.
 4. SLH = Short Leg Horizontal.
 5. LLH = Long Leg Horizontal.

End of Section

Section 05 5200

Guardrails and Handrails

Part 1 General

1.01 Scope of Work

- A. Furnish and install custom aluminum railing system, and fittings, as shown on the Drawings. Railings on open side(s) of stairs shall be handrail/guardrail combination as detailed. Handrails shall be provided on both sides of stairs whether or not stair has accompanying guardrail on the open side.
- B. Guardrails for equipment platforms shall be as shown on the Drawings and specified herein.
- C. New installed system shall match existing system installed in the Sludge Handling Building as close as practical in profile and configuration.

1.02 Related Work Specified Elsewhere

- A. Section 07 9200

1.03 Quality Assurance

- A. Reference Standards
 - 1. ADA - Americans with Disabilities Accessibility Standards.
 - 2. AWS D1.2 - American Welding Society.
 - 3. ASTM B211 - Aluminum-Alloy Bars, Rods, and Wire.
 - 4. ASTM B221 - Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
 - 5. ASTM B241 - Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.
 - 6. ASTM B483 - Aluminum and Aluminum-Alloy Drawn Tubes for General Purpose Applications.
 - 7. ASTM E935 - Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.
 - 8. ASTM E985 - Permanent Metal Railing Systems and Rails for Buildings.
 - 9. NAAMM – National Association of Architectural Metal Manufacturers.
 - 10. SSPC (Steel Structures Painting Council) - Steel Structures Painting Manual.
- B. Inspection:
 - 1. Work done in accordance with this specification shall be subject to inspection. OWNER/ENGINEER shall have access to all places of manufacture where materials are being produced or fabricated, or where tests are being conducted and shall be accorded full facilities for inspection and observation.

1.04 Submittals

- A. Shop Drawings and Product Data:
 - 1. Shop Drawings: Show complete layout, plan view, elevations, connections, details for fabrication and attachment to other elements and other installation details.
 - a. Include calculations signed and sealed by a State of Michigan Registered Professional responsible for the structural design of the railing system.

1.05 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.

Part 2 Products

2.01 Design Requirements

- A. Railing assemblies, wall rails, and attachments shall be designed to meet the requirements from the latest State of Michigan Building Code without damage or permanent set. Test in accordance with ASTM A935.
- B. 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.
- C. Prevent galvanic action and other forms of corrosion by isolating dissimilar metals, preventing direct contact with each other.
- D. Provide guardrail/handrail system and component parts from one source to assure consistency in quality and appearance.
- E. Guardrail/handrail system shall be fabricated and delivered to the site in the largest sections practical to minimize the number of field joints.

2.02 Materials

- A. Aluminum:
 - 1. Extruded tubing or pipe - Alloy 6063-T5 or T6 meeting ASTM B221.
 - 2. Reinforcing bars - Alloy 6061-T6 or T5 Meeting ASTM B-221.
 - 3. Extruded bars, shapes and moldings - Alloy 6063-T52 meeting ASTM B-221.
 - 4. Fasteners – Series 300 stainless steel.
 - 5. Finish – Clear brushed anodized (light circumferentially brushed before anodizing) AA-M32-C22-A41.

2.03 Aluminum Railing System

- A. Rails and Posts: Nominal 1-1/2 inch (38 mm) diameter, minimum schedule 40 aluminum pipe.
- B. Fittings: Elbows, T-shapes, brackets, etc., aluminum – flush with rail system.
- C. Mounting: Brackets, post receiver and flanges from same material as railing system.
- D. 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.
- E. Exposed Fasteners: Flush countersunk screws or bolts; consistent with design of railing.
- F. Toe Board: Extruded aluminum, channel shape or fabricated with stiffening ribs – flat aluminum stock is not acceptable.
- G. Aluminum Surfaces: Clear anodized finish.
- H. Apply one coat of bituminous paint per Section 09 9000 to concealed aluminum surfaces in contact with cementitious or dissimilar materials.

2.04 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. Provide anchors, required for connecting railings to structure.
- 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. 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.
- I. Accurately form components to each other and to building structure.
- J. Employ smooth curves by using radius elbows as opposed to mitering and welding.

- K. Where rail is mounted to concrete provide floor flange mounting at the base of each post.
- L. For removable railing, provide sleeves as detailed on the Drawings.
- M. Use appropriate end caps to close exposed open ends of all pipes.
- N. Accommodate for expansion and contraction of members and building movement without damage to connections or members.
- O. 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.

2.05 Manufacturers

- A. Julius Bloom & Co., Inc.
- B. Sterling Dula Architectural Products
- C. Superior Aluminum Products Inc.
- D. Wagner Enterprises.
- E. Golden Railing.
- F. Or Approved Equal

Part 3 Execution

3.01 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.

3.02 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.

3.03 Installation

- A. Install components plumb and level, accurately fitted, free from distortion or defects.
- B. Anchor railings to structure with anchors.
- C. Install posts into concrete and fill hole with non-shrink, non-metallic grout to ½" below the finished surface.
- D. Provide continuous bead of sealant around posts to facilitate drainage away from posts.
- E. Conceal bolts and screws whenever possible.

- F. Assemble with spigots and sleeves to accommodate tight joints and secure installation.
- G. Immediately upon completion of the installation clean all surfaces with clean water and a mild soap or detergent and rinse with clean water.
- H. Do not use acid solution, steel wool, or abrasives.

3.04 Erection Tolerances

- A. Maximum Variation From Plumb: 1/4 inch.
- B. Maximum Offset from True Alignment: 1/4.
- C. Maximum Out-of-Position: 1/4 inch.

End of Section

Division 06
Wood, Plastics, and Composites

Section 06 1053.13

Wood Blocking and Curbing

Part 1 General

1.01 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.

1.02 Related Sections

- A. Section 07 5323: Single Ply Roofing – Fully Adhered

1.03 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. WWPAA (Western Wood Products Association)

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Product Data: Provide technical data on wood preservative materials and application instructions.

1.05 Quality Assurance

- A. Perform Work in accordance with the following agencies:
 - 1. Lumber Grading Agency: Certified by ALSC.

Part 2 Products

2.01 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.

2.02 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.

2.03 Factory Wood Treatment

- A. Wood Preservative:
 - 1. Materials shall be pressure treated to meet AWWA UC3B with 0.25 pounds per cubic foot, minimum retention, of Alkaline Copper Quat (ACQ).

Part 3 Execution

3.01 Framing

- A. Set members level and plumb, in correct position.
- B. Place horizontal members flat, crown side up.

3.02 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

Division 07
Thermal and Moisture Protection

Section 07 1000 Dampproofing and Waterproofing

Part 1 General

1.01 Scope of Work

- A. This Section includes furnishing and applying thermal and moisture protection for the surfaces of structures constructed under this Contract, as indicated on the plans, including perimeter insulation, vapor barriers and damp proofing.

1.02 Submittals

- A. Submit manufacturer's literature of proposed products for review by ENGINEER in accordance with Section 01 3300.

1.03 Product Delivery, Storage, and Handling

- A. Unload and store in accordance with manufacturer's recommendations.

1.04 Environmental Requirements

- A. The temperature of the ambient air, surface and material during installation shall be in accordance with the manufacturer's recommendations.

Part 2 Products

2.01 Perimeter Insulation

- A. Use multi-cellular board of extruded polystyrene or polyurethane foam of thickness shown on the Plans; minimum compressive strength of 125 kPa; maximum water vapor transmission of 1.1 per inch; conforming to Federal Specification HH-I-524B, Type 11, Class B.

2.02 Vapor Barrier

- A. Use a 6-mil (150 μ m), polyethylene film.

2.03 Damp Proofing

- A. Use bituminous base for below grade surfaces and colorless, transparent nonstaining silicone compound for above grade surfaces.

2.04 Crystalline Waterproofing

- A. A cementitious crystalline type waterproofing material consisting of portland cement, silica sand and chemicals which chemically controls and permanently fixes non-soluble crystalline growth throughout the capillary voids of the concrete.

2.05 Acceptable Manufacturers

- A. Perimeter Insulation: Dow "Styrofoam"; United States Gypsum Company "Formula R"; or ENGINEER approved equal.
- B. Vapor Barrier: Polymeric "Visqueen"; "Durethane"; or ENGINEER approved equal.

- C. Crystalline Waterproofing: Xypex Concentrate or ENGINEER approved equal.

Part 3 Execution

3.01 Preparation

- A. Subgrade surfaces shall be smooth, free from voids, and sharp projections, and shall be to the lines and grades indicated on the Plans before vapor barrier, perimeter insulation, damp proofing, or waterproofing is installed.
- B. Prior to damp proofing or waterproofing, fill and finish flush with Portland cement mortar any cracks, holes, cavities or other surface defects.
- C. Clean surfaces of all dirt, dust, scale, laitance, curing compounds, oil, grease or other foreign material. Surfaces shall be dry and structurally sound. Apply grout coat of mortar to portions of brick and block surfaces to be backfilled against.

3.02 Installation of Perimeter Insulation

- A. Provide on foundation walls or under slabs as indicated on the Plans. Install and attach to walls as recommended by the manufacturer.

3.03 Installation of Vapor Barrier

- A. Provide under all floor slabs on subgrade as indicated on the Plans.
- B. Use widest practical, seamless width. Use 6-inch (150 mm) minimum laps with top lap placed in direction of concrete placement.
- C. Use extreme care in placing concrete reinforcement so as to not disturb or damage vapor barrier.
- D. Do not penetrate with stakes, concrete reinforcement or supports. Seal openings with tape in accordance with manufacturer's recommendations prior to concrete placement.

3.04 Installation of Damp Proofing

- A. Provide on the wet, exposed or backfilled side of all walls or slabs with wet, exposed-to-weather or backfill on one side and dry on the other side as indicated on the Plans.
- B. On backfilled surfaces use two (2) coats each applied at a rate of not less than 1-gallon per 100 square feet (4 L/10 m²) in accordance with manufacturer's recommendations. Use care to not permit material to get on any exposed surfaces. Remove such spillage or misapplication immediately. Allow material to thoroughly dry between coats and after final application.
- C. On exposed surfaces use two (2) coats each applied at a rate of not less than 1-gallon per 200 square feet (2 L/10 m²) in accordance with manufacturer's recommendations. Do not stain or discolor surfaces or allow runs or waves in applied material.

3.05 Installation of Crystalline Waterproofing

- A. Crystalline waterproofing shall be applied to green concrete or existing concrete which has been thoroughly saturated with clean water. Surfaces to be treated shall be moistened prior to application as required to insure proper migration of chemicals into the capillary voids in the concrete.

- B. Waterproofing material shall be mixed by volume with clean water which is free from salt or other deleterious materials. Waterproofing material shall be mixed in accordance with manufacturer's instructions.
- C. After repairs, patching and sealing has been done in accordance with manufacturers requirements, the concrete surfaces shall have a slurry of crystalline waterproofing applied in two coats at a rate of 1.5 lbs/syd per coat (8 kg/10 m²).
- D. Curing shall begin as soon as the waterproofing material has set up. Treated surfaces shall be fog sprayed three times a day for a three day period, or may be covered with damp burlap for three days.
- E. Crystalline Waterproofing may also be applied by mixing an approved admixture into the fresh concrete, according to the manufacturer's directions, at the time of placing concrete.

End of Section

Section 07 1355

Bentonite Geotextile Sheet Waterproofing

Part 1 General

1.01 Scope of Work

- A. The work of this section includes, but is not limited to, the furnishing and installing the following materials, per project specifications and drawings, or as directed by bentonite waterproofing manufacturer.

1.02 Related Work Specified Elsewhere

- A. Other specification Sections which directly relate to the work of this section include, but are not limited to, the following:
 - 1. Section 03 1100: Concrete Forming
 - 2. Section 03 2000: Concrete Accessories
 - 3. Section 03 3000: Cast-In-Place Concrete
 - 4. Section 31 2333: Structural Excavation and Backfill

1.03 System Description

- A. Provide bentonite waterproofing to prevent the passage of liquid water and install without defects, damage or failure. Waterproofing shall be two high strength geotextiles interlocked encapsulating minimum 1.10 lbs. per square foot (5.37 kg/sqm) granular Volclay sodium bentonite.

1.04 Submittals

- A. Prepare and submit the following in accordance with "Conditions of the Contract" and Section 01 3300, Submittals Procedures:
 - 1. Product Data: Submit manufacturer's product data, with complete general and specific installation instructions, recommendations, and limitations.
 - 2. Product Samples: Submit representative samples of specified materials.
 - 3. Material Certificates: Submit certificate(s) signed by manufacturer certifying materials comply with specified performance characteristics and physical requirements. Submit certification that waterproofing system and components, and protection materials are supplied by a single-source manufacturer.
 - 4. Contractor Certificate: At time of bid, submit written certification that installer has current Approved Applicator status with waterproofing material manufacturer.
 - 5. NSF Standard 61 Certification: Submit Official NSF Listing for standard bentonite geotextile waterproofing membrane confirming that product conforms to the requirements of NSF Standard 61 - Drinking Water System Components - Health Effects.

1.05 Quality Assurance

A. Installer Qualifications:

1. Installing company should have at least three (3) years experience in work of the type required by this section, who can comply with manufacturer's warranty requirements, and who is an Approved Applicator as determined by waterproofing system manufacturer.

B. Manufacturer Qualifications:

1. Bentonite geotextile waterproofing and all accessory products shall be provided by a single manufacturer with a minimum of 30 years experience in the direct production and sales of bentonite waterproofing systems.
2. Manufacturer shall be capable of providing field service representation during construction, approving an acceptable installer, recommending appropriate installation methods, and conducting a final inspection of the bentonite waterproofing system applied.

C. Pre-Installation Conference:

1. A pre-installation conference shall be held prior to commencement of field installation to establish procedures to maintain required working conditions and to coordinate this work with related and adjacent work.
2. Verify that final waterproofing and waterstop details comply with waterproofing manufacturer's current installation requirements and recommendations.
3. Pre-con meeting attendees should include representatives for OWNER, ENGINEER, and CONTRACTOR.

D. Materials:

1. Obtain bentonite geotextile waterproofing materials from a single manufacturer to assure material compatibility.

E. Water Sample Test:

1. Project site water sample supplied to manufacturer by CONTRACTOR to determine type of bentonite system (standard sodium bentonite or contaminate resistant (CR) sodium bentonite) to be utilized on the project.
2. Manufacturer shall conduct test free of charge.
3. CONTRACTOR is responsible for collection and shipment of one liter of actual site water.
4. Water should be shipped in uncontaminated, sealed plastic container to: CETCO Technical Center, Attn: BMG Water sample Technician, 1500 West Shure Drive, Arlington Heights, IL 60004. Also provide project name, city and state along with return address to forward test results.

1.06 Product Delivery, Storage, And Handling

A. Delivery and Handling:

1. Deliver materials in factory sealed and labeled packaging. Sequence deliveries to avoid delays, while minimizing onsite storage.
2. Handle and store following manufacturer's instructions, recommendations and material safety data sheets.
3. Protect from construction operation related damage and prolonged weather exposure. Remove damaged material from site and dispose of in accordance with applicable regulations.

B. Storage:

1. Do not double-stack pallets during shipping or storage.
2. During storage protect waterproofing materials from moisture, excessive temperatures and sources of ignition.
3. Provide cover, top and all sides, for materials stored on-site, allowing for adequate ventilation.

1.07 Project Conditions

A. Substrate Condition:

1. Proceed with work only when substrate construction and preparation work is complete and in condition to receive waterproofing system.

B. Weather Conditions:

1. Perform work only when existing and forecasted weather conditions are within the guidelines established by the manufacturer of the waterproofing materials.
2. Do not apply waterproofing materials into standing water or over ice and snow.
3. Though exposure to precipitation and ground water seepage typically will not adversely affect the waterproofing materials, CONTRACTOR shall maintain site conditions to remove standing water from precipitation or ground water seepage in a timely manner.
4. Should waterproofing materials be subjected to prehydration as a result of prolonged immersion, inspection of the material and written acceptance from the manufacturer is required prior to concrete or backfill placement.

1.08 Warranty

- A. Upon completion and acceptance of the work required by this section, the waterproofing materials manufacturer will provide a written five (5) year warranty, covering both materials and labor, to OWNER.

- B. Issuance of Manufacturer's Warranty requires the following:
1. System waterproofing products and drainage composite products shall have been provided by a single manufacturer;
 2. Installation of waterproofing products and prefabricated drainage composite by Manufacturer's Approved Applicator;
 3. Installation inspected by certified Independent Inspection Firm per Article 1.06E;
 4. Waterproofing materials must be installed in all applicable horizontal and vertical cold pour concrete construction joints and around applicable penetrations.
- C. Manufacturer's warranty shall be independent from any other warranties made by CONTRACTOR under requirements of the Contract Documents and may run concurrent with the other warranties.

Part 2 Products

2.01 Acceptable Manufacturer

- A. Provide Voltex bentonite interlocked-geotextile waterproofing with applicable accessories as manufactured by Colloid Environmental Technologies Company (CETCO), or ENGINEER-approved equal.

2.02 Materials

- A. General:
1. Sodium Bentonite:
 - a. Specially selected Wyoming granular sodium bentonite with 90% passing through a 20-mesh sieve and less than 10% passing through a 200-mesh sieve.
 - b. Sodium bentonite shall have a 2 gram free swell minimum volume of 16 cc and a maximum fluid loss of 18ml in de-ionized water.
 2. NSF Certified:
 - a. Standard bentonite geotextile waterproofing membrane shall be certified by NSF International to conform to the requirements of NSF Standard 61 - Drinking Water System Components - Health Effects.
- B. Voltex Bentonite Geotextile Waterproofing:
1. Volclay Voltex®: 4'x15' (1.2x4.5m) roll of interlocked geotextiles encapsulating a minimum of 1.10 lbs. per square foot (5.37 kg/sqm) of granular sodium bentonite. Composite shall consist of one woven and one non-woven polypropylene geotextile, interlocked using a needle-punching process that produces several interlocks per square inch (6.45 sq. cm) over the entire surface area of product.

2. Volclay Voltex® CR: 4'x15' (1.2x4.5m) roll of interlocked geotextiles encapsulating a minimum of 1.10 lbs. per square foot (5.37 kg/sqm) of contaminant resistant granular sodium bentonite. Composite shall consist of one woven and one non-woven polypropylene geotextile, interlocked using a needle-punching process that produces several interlocks per square inch (6.45 sq. cm) over the entire surface area of product.

C. Both Volclay Voltex and Voltex CR have the following performance properties:

Property	Test Method	Typical Value
Peel Adhesion to Concrete	ASTM D903 mod.	15 lbs. /in. (2.6 kN/m) min.
Hydrostatic Pressure Resistance	ASTM D5385 mod.	231 ft. (70 m)
Permeability	ASTM D5084	1×10^{-9} cm/sec.
Grab Tensile Strength	ASTM D4632	95 lbs. (422 N)
Puncture Resistance	ASTM D4833	100 lbs. (445 N) min.
Low Temperature Flexibility	ASTM D1970	Unaffected at -25°F (-32°C)
Geotextile Interlock Peel	ASTM D4632	15 lbs. (65 N)

D. Accessory Waterproofing Products:

1. Accessory waterproofing materials shall be provided by the bentonite waterproofing manufacturer or shall have manufacturer's written approval for substitution.
 - a. Volclay Bentoseal®: Trowel grade sodium bentonite compound used as detailing mastic around penetrations, corner transitions and grade terminations.
 - b. Volclay Hydrobar Tubes: 2" (50 mm) diameter x 2' (60 cm) long, water soluble tube container filled with granular sodium bentonite.
 - c. Volclay Waterstoppage®: 50 lbs. (22.7 kg) bag of granular Volclay sodium bentonite.
 - d. Volclay SeamTape®: 2" (50 mm) wide butyl rubber sealant tape.
 - e. Termination Bar: Min. 1" (25 mm) wide aluminum bar with pre-punched holes on 12" (300 mm) centering for fastening.
 - f. Cementitious Wall Board: ½" thick cementitious board for protection of waterproofing during the removal of metal soldier pile cap and top lagging boards.
 - g. Volclay TB-Boot®: preformed EPDM tie-back cover or field fabricated 26 gauge galvanized sheet metal tie-back covers.

Part 3 Execution

3.01 General

- A. Comply with contract documents and manufacturer's product data, including product application and installation instructions.

3.02 Substrate Inspection and Conditions

A. General:

1. CONTRACTOR, with ENGINEER present, shall examine conditions of substrates and other conditions under which this section work is to be performed and notify CONTRACTOR, in writing, of circumstances detrimental to the proper completion of the work.
2. Do not proceed with work until unsatisfactory conditions are corrected and are acceptable for compliance with manufacturer's warranty requirements.
3. General substrate conditions acceptable for the waterproofing installation are listed below. For conditions not covered in this Section, contact the waterproofing manufacturer for guidance.

B. Soil Substrates:

1. Site conditions allowing, Voltex applications do not require a mud-working slab.
2. Grade substrates should consist of well-leveled soils without voids and debris, and compacted to a minimum of 85% Modified Proctor density.
3. If substrate consists of large aggregate, place a high-strength geotextile layer over the aggregate and then provide several inches of compacted soil or sand for uniform support and containment of waterproofing sheets.

C. Wood Timber Shoring:

1. Wood lagging shoring should extend to the lowest level of the waterproofing installation with any voids or cavities exterior of the lagging timbers filled with compacted soil or cementitious grout.
2. Interior surface of lagging boards should be planar and tight together with gaps less than 1" (25 mm).
3. Gaps in excess of 1" should be filled with cementitious grout, wood, extruded polystyrene (40 psi min.) or compacted soil.
4. Do not use plywood or other surface treatment over large lagging gaps that leaves the cavity void.

D. Cut Rock Face or Auger Cast Caisson Shoring Walls:

1. Interior surface of cut rock and concrete auger pile retention walls should be planar without irregular surface conditions, voids, and sharp transitions that would leave a void space to the outside of the waterproofing installation.
2. Irregular rock, void pockets, cracks, sharp concave transitions should be completely filled or smoothed with cementitious grout, shotcrete, or other approved solid material.

E. Concrete:

1. Reinforced structural slabs should be a minimum of 6" (150 mm) thick when placed on a working mud slab.
2. Reinforced concrete slab(s) on compacted grade shall be a minimum of 4" (100 mm) thick.
3. When hydrostatic conditions exist, install Voltex under all footings, elevator pits and grade beams.
4. Cast-in-place concrete to receive waterproofing shall be of sound structural grade with a smooth finish, free of debris, oil, grease, laitance, dirt, dust, or other foreign matter which will impair the performance of the waterproofing and drainage system and which do not comply with manufacturer's warranty requirements.
5. Voltex can be installed on green structural concrete as soon as the forms are removed. There is no product limitation regarding a minimum concrete curing time requirement for Voltex to be installed over structural concrete. Manufacturer recommends gaining instructions from ENGINEER regarding any site specific concrete curing time requirement.
 - a. Horizontal deck or roof concrete surfaces should be sloped for proper drainage.
 - b. Form fins, ridges, and other protrusions should be level and smooth with monolithic concrete surface. Honeycombing, aggregate pockets, tie-rod holes and other voids should be completely filled with non-shrink cementitious grout and level with monolithic concrete surface.
 - c. Expansion joints should receive applicable expansion joint sealant product manufactured by others prior to the installation of the Voltex Waterproofing System. Expansion joint material is the primary seal at the expansion joint and the expansion joint material manufacturer is responsible for water tightness of the joint.

3.03 Surface Preparation

- A. Remove dirt, debris, oil, grease, cement laitance, or other foreign matter which will impair or negatively affect the performance of the waterproofing and drainage system.
- B. Protect adjacent work areas and finish surfaces from damage or contamination from waterproofing products during installation operations.

3.04 General Installation Guidelines

- A. Install Voltex Waterproofing System with the dark gray woven geotextile side facing the concrete to be waterproofed in both horizontal and vertical applications. Overlap Voltex membrane edges a minimum 4" (100 mm) or greater as defined herein.
- B. Expansion Joints:

1. Voltex waterproofing is not an expansion joint filler or sealant, but may be used as an expansion joint cover over a properly installed expansion joint material placed during substrate preparation.
2. To use Voltex as an expansion joint cover, trowel 1/8" (3 mm) thick, 6" (150 mm) wide layer of Bentoseal centered over expansion joint.
3. Install a 24" (60 cm) wide strip of Voltex centered over the expansion joint. Then install the main course of Voltex.

3.05 Slab / Footing Edge Voltex Transition Course

- A. Provide a minimum of 6" (150 mm) overlap between underslab and vertical wall waterproofing. Secure overlap with washer-head fasteners a minimum of 24" (600 mm) on center and apply Bentoseal to the overlap edge.
- B. At the slab/footing form edge, secure Voltex sheet horizontally oriented (dark gray woven geotextile facing installer) to the top inside edge of the exterior slab/footing form with the sheet conforming to the interior form sides and then extending out onto the horizontal slab substrate a minimum 12" (300 mm). Overlap edges of adjacent Voltex sheets a minimum 4" (100 mm) and secure to prevent sheet movement during construction or concrete placement.

3.06 Under Slab Voltex Installation

- A. Reinforced structural foundation slabs should be a minimum of 6" (150 mm) thick when placed on a working mud slab. Reinforced concrete slab(s) on compacted grade shall be a minimum of 4" (100 mm) thick. Install Voltex under all footings, elevator pits and grade beams when hydrostatic conditions exists or are anticipated per the historical high ground water elevation reported in the project's geotechnical documents.
- B. Install underslab Voltex membrane (dark gray woven geotextile side up) extending to interior edge of slab/footing form edge, fully overlapping the 12" (300 mm) horizontal tail of the Voltex slab edge sheet installed in Step B, Section 3.04. Overlap edges of adjacent Voltex sheets a minimum 4" (100 mm) and secure to prevent sheet movement during construction or concrete placement.
- C. Place Voltex directly on properly prepared substrate (dark gray woven geotextile side up facing installer) with adjoining edges overlapped a minimum of 4" (100 mm). Stagger sheet end seams a minimum of 24" (60 cm). Mechanically fasten or staple Voltex as required to prevent movement from construction operations or concrete placement. When the slab is poured in sections, extend Voltex a minimum 12" (300 mm) beyond the slab edge to enable proper overlapping.
- D. Detail all slab penetrations, grade beams, and pile caps, install 1/4" (6 mm) thick layer of Waterstoppage extending a 6" (150 mm) radius. Cut Voltex to fit snugly around penetrations and pile caps. Around base of penetrations trowel 3/4" (18 mm) thick fillet of Bentoseal and extend the Bentoseal up the penetration 1-1/2" (38 mm) and onto the Voltex. Around base of pile caps and grade beams trowel 3/4" (18 mm) thick fillet of Bentoseal and extend the Bentoseal up the cap and onto Voltex a minimum 2" (50 mm).

- E. Inspect finished Voltex installation and repair any damaged material prior to concrete slab placement. Assure that Voltex is not displaced during concrete placement.
- F. Volclay Waterstop-RX shall be installed in all slab joints, around applicable slab penetrations and structural members. Refer to Waterstop-RX Product Manual for further installation procedures and guidelines.

3.07 Backfilled Cast-In-Place Concrete Walls

- A. Place Hydrobar Tubes along the wall/footing intersection with ends "buted" tightly together to form a continuous installation.
- B. Trowel 3/4" (18 mm) thick, continuous Bentoseal fillet at all inside wall corner transitions. Trowel Bentoseal form-tie pockets/patches and any slightly irregular honeycomb areas.
- C. Starting at the base of the wall, install Voltex sheet horizontally (dark gray woven geotextile against the wall) covering the Hydrobar Tubes and extending onto the footing a minimum of 6" (150 mm). For hydrostatic conditions, cover the entire footing and overlap waterproofing membrane from underslab work a minimum of 6" (150 mm). Attach Voltex using washer-headed mechanical fasteners centered 24" (60 cm) around the sheet edge. Overlap all adjacent sheet edges a minimum 4" (100 mm). Stagger all vertical overlap seams a minimum of 12" (300 mm).
- D. After the bottom horizontal course, Voltex sheets can be installed either vertically or horizontally oriented. Continue Voltex installation up wall to finished grade elevation, staggering all sheet roll ends of adjacent courses a minimum 12" (300 mm). Do not allow horizontal Voltex overlap joints to run at same elevation as the concrete pour lift joints. Overlap all adjacent Voltex sheet edges a minimum 4" (100 mm).
- E. Cut Voltex to fit snugly around penetrations. Detail around all penetrations with 3/4" (18 mm) cant of Bentoseal. Completely fill any space between the penetration and Voltex edge. Extend Bentoseal 1/4" (6 mm) thick over substrate a minimum radius of 1-1/2" (38 mm) and onto penetration.
- F. Terminate at grade with metal termination bar fastened 12" (300 mm) on center. Cover top edge of Voltex with 1/2" (12 mm) thick, 2" (50 mm) wide layer of Bentoseal.
- G. Inspect finished Voltex installation and repair any damaged material prior to backfill placement. Assure that Voltex is not displaced during backfill placement or soil compaction.

3.08 Backfill Excavated Cast-In-Place Concrete Walls

- A. Closely coordinate Voltex installation with Backfill conducted under Division 2 work. Care should be used during backfill operation to avoid damage to the waterproofing system.
- B. Follow generally accepted practices for backfilling and compaction. Backfill should be added in 6" to 12" (150 - 300 mm) lifts and compacted to a minimum 85% Modified Proctor density. If gravel backfill, specify angular aggregate <3/4" (18mm) with fines.

3.09 Clean Up

- A. Clean areas where adjacent finished surfaces are soiled by work of this Section. Remove all tools, equipment and remaining product on-site. Dispose of section work debris and damaged product following all applicable regulations.

End of Section

Section 07 1900 Water Repellent Coating

Part 1 General

1.01 Section Includes

- A. Water repellent coating applied to exterior stone and brick as shown on the Drawings.

1.02 Related Sections

- A. Section 04 2200: Unit Masonry
- B. Section 07 9000: Joint Sealers

1.03 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Product Data: Provide details of product description, tests performed, limitations to coating, cautionary procedures required during application, and chemical properties including percentage of solids.
- C. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.
- D. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

1.04 Qualifications

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 10 years' experience.
- B. Applicator: Company specializing in performing the work of this section with minimum 3 years' experience.

1.05 Mockup

- A. Provide mockup of surface to be coated under provisions of Section 01 4500, Quality Control.
- B. Prepare coated surface 36 x 36 inch (1 x 1 m) in size.
- C. Apply material to test area using the same equipment as intended for the job. Sample area will be allowed to cure for a minimum of 48 hours.
- D. Mockup may, at the discretion of the Engineer, remain as part of the Work.

1.06 Delivery, Storage, and Handling

- A. Deliver, store, protect and handle products to site under provisions of Section 01 6000, Product Requirements.
- B. Protect coating liquid from freezing.

1.07 Environmental Requirements

- A. Do not apply coating when ambient or surface temperature is lower than 50 degrees Fahrenheit (10 degrees Celsius) or higher than 100 degrees Fahrenheit (38 degrees Celsius).

1.08 Extra Materials

- A. Furnish under provisions of Section 01 7700, Closeout Procedures.
- B. Provide two gallons of coating, in manufacturer's labeled, unopened, containers.

Part 2 Products**2.01 Manufacturers**

- A. ProSoCo Inc.:
 - 1. At Brick Masonry – Sure Klean Siloxane PD.
 - 2. At Limestone – Sure Klean Natural Stone Treatment WB Plus.
- B. Substitutions: Under provisions of Section 01 2513, Substitution Procedures.

2.02 Material

- A. A water-based silane/siloxane water repellent sealer for exterior, vertical, above-grade applications on stone, concrete and masonry. A clear water-repellent, film-free formula protects buildings from moisture damage and reduces efflorescence, atmospheric staining, and scaling associated with freeze/thaw cycles.
- B. Water repellent material shall have the following minimum performance.
- C. Reduction in water absorption: 98.9 percent per ASTM C 67.
- D. Reduction in water absorption: 94.8 percent per ASTM C 642.

Part 3 Execution**3.01 Examination**

- A. Verify joint sealants are installed and cured.
- B. Verify compatibility of material with joint sealants used.
- C. Verify surfaces to be coated are dry, clean, and free of efflorescence, oil, or other matter detrimental to application of coating. Clean surfaces in accordance with manufacturer recommendations and requirements.

3.02 Preparation

- A. Delay work until masonry mortar or concrete substrate is cured a minimum of 60 days or as recommended by the manufacturer of the water repellent coating.
- B. Remove loose particles and foreign matter.
- C. Remove oil or foreign substance with a chemical solvent which will not affect coating.
- D. Scrub and rinse surfaces with water and let dry.

3.03 Application

- A. Apply coating in accordance with manufacturer's instructions.
- B. Apply each coat of material in one continuous, uniform coat; actual number of coats applied shall be as recommended by material manufacturer to meet manufacturer's standard warranty requirements.

3.04 Protection to Finished and Adjacent Work

- A. Protect adjacent surfaces not scheduled to receive coating.
- B. Protect landscaping, property, and vehicles.
- C. If applied to unscheduled surfaces, remove immediately by a method instructed by coating manufacturer.

End of Section

Section 07 5323

Single-Ply Roofing - Fully Adhered - Conventional

Part 1 General

1.01 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 existing roof-top equipment.
- C. Rigid insulation.

1.02 Related Sections

- A. Section 06 1053.13: Wood Blocking and Curbing
- B. Section 07 6200: Sheet Metal Flashing and Trim

1.03 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.

1.04 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.

1.05 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; termination condition at parapets.

- C. Samples: Submit two 6 inches x 6 inches in size illustrating insulation.

1.06 Submittals for Information

- A. Refer to Section 01 3300, Submittal Procedures.
- 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 01 4500, Quality Control.
- E. Reports: Indicate procedures followed; ambient temperatures, humidity, wind velocity during application.

1.07 Quality Assurance

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with three (3) years' experience.
- B. Installer: Company specializing in performing the work of this section with three (3) years' experience and approved by system manufacturer.
- C. Perform Work in accordance with NRCA Roofing and Waterproofing Manual and manufacturer's instructions.

1.08 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 I-90, in accordance with FM Construction Bulletin 1-28.

1.09 Pre-Installation Meeting

- A. Convene one week before starting work of this section in accordance with Section 01 3119, Project Meetings.

1.10 Delivery, Storage, And Protection

- A. Refer to Section 01 6000, Product Requirements, for information regarding requirements for transporting, handling, storing, and protection.
- B. Store products in weather protected environment, clear of ground and moisture.

1.11 Environmental Requirements

- A. Refer to Section 01 6000, Product Requirements, for environmental conditions affecting products on site.

- B. Do not apply roofing membrane during inclement weather and ambient temperatures below 32 degrees Fahrenheit or above 95 degrees Fahrenheit.
- 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 the work with the installation of associated metal flashings, as the work of this Section proceeds.

1.13 Warranty

- A. Manufacturer shall provide a 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. 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

2.01 Manufacturers - Membrane Material

- A. Firestone – RubberGard EPDM Membrane (60 mil)
- B. Johns Manville – 60NR
- C. Carlisle - SureSeal (60 mil)
- D. Substitutions – None Permitted.

2.02 Membrane and Associated Materials

- A. Membrane: EPDM non-reinforced, 0.060-inch-thick, utilizing maximum roll width to reduce number of seams; color - white.
- B. Seaming Materials: As recommended by membrane manufacturer.

2.03 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, vapor barriers, termination bars and reglets.

2.04 Insulation Materials

- A. 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 for warranty requirements specified.
 - 2. Type 2 (Thermal Insulation): Polyisocyanurate foam core bonded to universal fiber glass reinforced facer sheets.
- 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 (for roofing system to be provided).
 - 4. Board Edges: Square.
- 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.

2.05 Flashings

- A. Flexible Flashings: Same material as membrane EPDM; white color, as recommended by the manufacturer.

2.06 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 on center max. Cut termination bars at inside and outside corners, do not bend around corners.

- D. Sheet Vapor Retarder: Conforming to FM requirements, self-adhering, Class I retarder (perm rating of 0.02, as recognized by MBC); non-slip surface, UV resistant; 82 lb. rolls; membrane shall be V-Force or approved equal.

Part 3 Execution

3.01 Examination

- A. Verify that surfaces and site conditions are ready to receive work.
- B. Verify deck is supported and secure.
- C. Verify deck is clean and smooth, free of depressions, waves, or projections.
- D. Verify deck surfaces are dry and free of snow or ice.
- E. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set.

3.02 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.

3.03 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.
- B. Outdoor temperatures must be 35 degrees Fahrenheit and rising for adhesive installation.
- C. Store adhesive in 60 degrees to 80 degrees Fahrenheit until ready to use.
- D. Adhesive shall be 60 degrees to 80 degrees Fahrenheit when installed.
- E. Adhesive shall be installed in accordance with the manufacturer's requirements based on the insulation used and an I-90 uplift requirement.
- F. Verify proper mixing prior to applying adhesive to deck, no marbling in the adhesive is allowed.
- G. Do not allow bead of adhesive to "skin over" before installing insulation board.
- H. Pull test shall be required each day to verify applicability for that day.

- I. Insulation boards shall be weighted down after placement until adhesive is set to insure full continuous contact.
- J. 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.

3.04 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.

3.05 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.

- F. Roof Walk Pads: Minimum 30-inch x 30-inch, white 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.

3.06 Field Quality Control

- A. Manufacturer shall inspect the completed roof for proper installation and ENGINEER shall be notified a minimum of 48 hours in advance of the date of the inspection.
- B. Correct identified defects or irregularities.

3.07 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.

3.08 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

Section 07 5600

Cold Fluid Applied Roofing

Part 1 General

1.01 Scope of Work

- A. Protective coating for the roof of the Influent Building as shown on the Drawings.
- B. Roof coating preparation including preparation of concrete deck and substrate to receive fluid-applied waterproofing roofing.
- C. Application of fluid-applied waterproofing roof membrane and flashings to prepared existing concrete deck.

1.02 Submittals

- A. Prepare and submit the following in accordance with "Conditions of the Contract" and Section 01 3300, Submittals Procedures:
 - 1. Product Data: Submit manufacturer's product data, with complete general and specific installation instructions, recommendations, and limitations.
 - 2. Product Samples: Submit representative samples of specified materials.
 - 3. Material Certificates: Submit certificate(s) signed by manufacturer certifying materials comply with specified performance characteristics and physical requirements. Submit certification that system and components, and protection materials are supplied by a single-source manufacturer.
 - 4. Contractor Certificate: At time of bid, submit written certification that installer has current Approved Applicator status with material manufacturer.
 - 5. NSF Standard 61 Certification: Submit Official NSF Listing for standard roof coating system confirming that product conforms to the requirements of NSF Standard 61 - Drinking Water System Components - Health Effects.

1.03 Quality Assurance

- A. Installer Qualifications:
 - 1. Installing company should have at least three (3) years' experience in work of the type required by this section, who can comply with manufacturer's warranty requirements, and who is an Approved Applicator as determined by system manufacturer.
- B. Manufacturer Qualifications:
 - 1. Waterproofing and all accessory products shall be provided by a single manufacturer with a minimum of 20 years' experience in the direct production and sales of specified waterproofing systems.
 - 2. Manufacturer shall be capable of providing field service representation during construction, approving an acceptable installer, recommending appropriate installation methods, and conducting a final inspection of the waterproofing system applied.

C. Pre-Installation Conference:

1. A pre-installation conference shall be held prior to commencement of field installation to establish procedures to maintain required working conditions and to coordinate this work with related and adjacent work.
2. Verify that final waterproofing and waterstop details comply with waterproofing manufacturer's current installation requirements and recommendations.
3. Pre-con meeting attendees should include representatives for OWNER, ENGINEER, and CONTRACTOR.

D. Materials:

1. Obtain waterproofing roofing materials from a single manufacturer to assure material compatibility.

E. Roofing Inspector Qualifications: A technical representative of the manufacturer (not engaged in the sale of products) experienced in the installation and maintenance of the specified roofing system, shall be engaged to provide observation services by the CONTRACTOR to review the installation of the waterproofing roofing system. This observer shall be qualified to perform roofing observation and inspection specified in Field Quality Control Article, to determine Installer's compliance with the requirements of this Project and approved by the manufacturer to issue warranty certification. The Roofing Inspector shall be one of the following:

1. An authorized full-time technical employee of the manufacturer.
2. An independent party certified as a Registered Roof Observer by the IIBEC, retained by the Contractor or the Manufacturer and approved by the Manufacturer.

1.04 Product Delivery, Storage, And Handling

A. Delivery, Storage and Handling:

1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
2. Handle and store roofing materials, and place equipment in a manner to avoid significant or permanent damage to deck or structural supporting members.
3. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting.

1.05 Project Conditions

- A. Protect building, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from roofing operations.
- B. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.

- C. Weather Limitations: Proceed with roofing work only when existing and forecasted weather conditions permit Work to proceed without water entering into existing roofing system or building.
 - 1. Store all materials prior to application at temperatures between 60 and 90 degrees Fahrenheit.
 - 2. Apply coatings within range of ambient and substrate temperatures recommended by manufacturer. Do not apply materials when air temperature is below 40 or above 85 degrees Fahrenheit, providing the substrate is a minimum of 5 degrees Fahrenheit above the dew point.
 - 3. Do not apply roofing in snow, rain, fog, or mist.
- D. Daily Protection: Coordinate installation of roofing so insulation and other components of roofing system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
- E. Owner will occupy portions of building immediately below roofing area. Conduct roofing so OWNER's operations will not be disrupted. Provide Owner with not less than 72 hours' notice of activities that may affect OWNER's operations.

1.06 Warranty

- A. Manufacturer: Manufacturer's standard warranty form, covering work of this Section, in which manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within warranty period.
 - 1. Warranty Period: 20 years from date of completion.
- B. Installer Warranty: Installer's warranty signed by Installer, covering the Work of this Section on form acceptable to Roofing Manufacturer and OWNER.
 - 1. Warranty Period: 2 years from date of completion.

Part 2 Products

2.01 Acceptable Manufacturer

- A. Tremco – AlphaGuard PUMA (80 mils)
- B. Substitutions – Under provisions of Section 01 6000.

2.02 Performance Requirements

- A. General: Provide recoated roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.
 - 1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
- B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.
- C. Roofing System Design: Provide roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency in accordance with ANSI/FM 4474, UL 580, or UL 1897, and to resist uplift pressures.

1. All Zones (Corner, Perimeter, and Field-of-Roof) Uplift Pressures: As indicated on Drawings.
- D. Flashings: Provide base flashings, perimeter flashings, detail flashings and component materials that comply with requirements and recommendations of the following:
 1. Roof system manufacturer's construction details and recommendations.
 2. NRCA Roofing Manual (Sixth Edition) for construction details and recommendations.
 3. SMACNA Architectural Sheet Metal Manual (Seventh Edition) for construction details.
- E. Exterior Fire-Test Exposure: ASTM E 108, Class A; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

2.03 Materials

- A. General: Roofing materials recommended by roofing system manufacturer for intended use and compatible with components of existing membrane roofing system.
- B. Temporary Roofing Materials: Selection of materials and design of temporary roofing is responsibility of Contractor.
- C. General: Provide adhesive and sealant materials recommended by roofing manufacturer for intended use and compatible with roofing materials.
 1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

2.04 Fluid Applied Roofing Membrane

- A. Polyurethane Elastomeric Fluid-Applied System: Two-coat fluid-applied roofing membrane formulated for application over prepared roof substrate.
 1. Polyurethane-modified methyl methacrylate reinforced roof coating system base coat, two-part moisture-curing for use with a compatible top coat.
 2. Basis of design product: Tremco, AlphaGuard PUMA Base Coat.
 3. Combustion Characteristics, UL790: Class A, for two-coat system.
 4. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 0 g/L.
 5. Tensile Strength, ASTM D5147: 177 lbf/in (31.1 N/mm).
 6. Elongation, Reinforced, ASTM D5147: 40 percent.
 7. Crack Bridging, ASTM D5147: Pass- 2 mm.
 8. Hardness, Shore A, minimum, ASTM D2240: 93.
 9. Minimum Thickness, Base Coat: 40 mils (1 L/m²) plus 40 wet mils (1 L/m²)

- B. Polyurethane-modified methyl methacrylate roof coating system top coat, two-component 0 VOC, UV resistant, for application over compatible base coat.
 - 1. Basis of design product: Tremco, AlphaGuard PUMA Top Coat.
 - 2. Combustion Characteristics, UL 790: Class A, for two-coat system.
 - 3. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 0 g/L.
 - 4. Tensile Strength, ASTM D5147: 177 lbf/in (31.1N/mm).
 - 5. Elongation, Reinforced, ASTM D5147: 40 percent.
 - 6. Crack Bridging, ASTM D5147: Pass, 2 mm.
 - 7. Hardness, Shore A, minimum, ASTM D2240: 93.
 - 8. Solar Reflectance Index (SRI), minimum, ASTM E1980: 95.
 - 9. Minimum Thickness: 20 mils (0.50 mm) wet over cured base coat.

2.05 Auxiliary Roofing Materials

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with existing roofing system and fluid-applied roofing system.
- B. Concrete Primer:
 - 1. Primer, Methyl Methacrylate: Two-component primer for concrete and metal substrates for application of PUMA coatings.
 - a. Basis of design product: Tremco, AlphaGuard PUMA Primer - 107.
 - b. Coverage Rate: 1 gal/100 sq. ft (16 mils) (0.40 mm) wet.
- C. Metal Surface Primer:
 - 1. Primer, Methyl Methacrylate: Two-component primer for concrete and metal substrates for application of PUMA coatings.
 - a. Basis of design product: Tremco, AlphaGuard PUMA Primer - 107.
 - b. Coverage Rate: 1 gal/100 sq. ft (16 mils) (0.40 mm) wet.
- D. Reinforcing Fabric:
 - 1. Polyester Reinforcing and Protection Fabric: 100 percent stitch-bonded mildew-resistant polyester fabric intended for reinforcement of compatible fluid-applied membranes and flashings and as a protection layer under pavers or stone aggregates.
 - a. Basis of design product: Tremco, Permafab.
 - b. Tensile Strength, Minimum, ASTM D1682: 50 lbf (23 kg) avg..
 - c. Elongation, Minimum, ASTM D1682: 60 percent.
 - d. Tear Strength, Minimum, ASTM D1117: 16 lbf (7.3 kg) avg..
 - e. Weight: 3 oz./sq. yd (102 g/sq. m).
- E. Joint Sealants:
 - 1. Joint Sealant, Polyurethane: ASTM C920, Type S, Grade NS, Class 50 single-component moisture curing sealant, formulated for compatibility and use in dynamic and static joints; paintable.
 - a. Basis of design product: Tremco, TremSEAL Pro.
 - b. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 40 g/L.
 - c. Hardness, Shore A, ASTM C661: 40.
 - d. Adhesion to Concrete, ASTM C794: 35 pli.

- e. Tensile Strength, ASTM D412: 350 psi (2413 kPa).
- f. Color: Closest match to substrate.

2.06 Walking Surface Material

- A. Polyurethane-modified methyl methacrylate top coat slip resistant: second top coat, with broadcast slip resistant aggregate.
 - 1. Basis of design product: Tremco, AlphaGuard PUMA Top Coat Slip Resistant.
 - 2. Minimum Thickness: 16 wet mils, (0.40 mm) wet; over cured top coat.
 - 3. Silica Sand Aggregate: 20 to 30 lb/100 sq. ft..
 - 4. Color: As selected from manufacturer's standard colors.

Part 3 Execution

3.01 Examination

- A. Examine roofing substrates, with Installer present, for compliance with requirements and for other conditions affecting application and performance of fluid-applied roofing.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance.
 - 2. Verify that substrates are sound, visibly dry and free of moisture.
 - 3. Verify that substrates have adequately cured to enable proper bond with base coat.
 - 4. Application of fluid-applied roofing indicates acceptance of surfaces and conditions.

3.02 Preparation, General

- A. Protect existing roofing system that is indicated not to receive fluid-applied roofing, and adjacent portions of building and building equipment.
- B. Remove existing equipment on roof necessary to ensure a continuous roof and flashing system. Denote on drawings the metal hatches, and conduit line sitting on concrete deck.
- C. Shut down air intake equipment in the vicinity of the Work in coordination with OWNER. Cover air intake louvers before proceeding with coating work that could affect indoor air quality or activate smoke detectors in ductwork.
 - 1. Verify that rooftop utilities and service piping affected by the Work have been shut off before commencing Work.
 - 2. Prevent dust, vapors, gases, and odors from entering occupied building during roof installation. When shutting down or blocking air intakes, provide makeup air or additional intake air from sources away from the work area.

3.03 Concrete Deck Preparation

- A. Concrete Deck Preparation, General: Repair, clean, and prepare concrete to sound condition free of grease, oils, coatings, dust, curing compounds and other contaminants.
- B. Testing: Following surface preparation, perform testing to verify concrete substrate is adequate prepared to receive fluid-applied roofing in accordance with manufacturer's written instructions.

1. Pull Test: Verify that the cleaned surface pulls concrete when tested per ASTM D 4541.
2. Moisture Test: Verify that concrete substrate is visibly dry and free of moisture when tested by plastic sheet method per ASTM D 4263.

3.04 Preparation of Existing Flashings

- A. Existing Flashing and Detail Preparation: Repair flashings, copings, and other roof-related sheet metal and trim elements. Reseal joints, replace loose or missing fasteners, and replace components that cannot be repaired to weathertight and like-new condition.
 1. Clean substrates of contaminants such as asphalt, sheet materials, dirt, and debris, and prepare for application of re-coating system.

3.05 Fluid-Applied Flashing Application

- A. Surface Priming: Prime flashing substrate with specified primer at rate indicated in Part 2 product listing and allow primer to dry.
- B. Fluid-Applied Flashing and Detail Base Coat Application: Complete base coat and fabric reinforcement at parapets, curbs, penetrations, and drains prior to application of field of fluid-applied membrane. Apply flashing base coat in accordance with manufacturer's written instructions.
 1. Apply base coat on prepared and primed surfaces and spread coating evenly. Extend coating minimum of 8 inches or 3 brick courses (200 mm) up vertical surfaces and 4 inches (100 mm) onto horizontal surfaces.
 2. Back roll to achieve not less than minimum coating thickness indicated in Part 2 product listing, unless greater thickness is recommended by manufacturer. Verify application thickness as work progresses.
 3. Fabric Reinforcement: Place fabric reinforcement onto wet base coat. Lap adjacent flashing pieces of fabric minimum 3 inches along edges and 6 inches at end laps.
 - a. Apply second base coat over installed fabric reinforcement and back roll to achieve not less than minimum coating thickness indicated in Part 2 product listing, unless greater thickness is recommended by manufacturer. Verify application thickness as work progresses.
 4. Allow base coat to cure prior to application of top coat.
 5. Following curing of base coat and prior to application of top coat, sand raised or exposed edges of fabric reinforcement.

3.06 Fluid-Applied Membrane Application

- A. Concrete Repair: Patch concrete surface with concrete repair resin products compatible with fluid-applied membrane roofing system.
- B. Surface Priming: Prime flashing substrate with specified primer at rate indicated in Part 2 product listing and allow primer to dry.
- C. Base Coat: Apply base coat to field of membrane in accordance with manufacturer's written instructions. Apply base coat on prepared and primed surfaces and spread coating evenly.

1. Apply base coat on prepared and primed surfaces and spread coating evenly. Extend coating minimum of 8 inches (200 mm) up vertical surfaces and 4 inches (100 mm) onto horizontal surfaces.
 2. Back roll to achieve not less than minimum coating thickness indicated in Part 2 product listing, unless greater thickness is recommended by manufacturer. Verify application thickness as work progresses.
 3. Apply first base coat over prepared concrete deck and flashings and back roll to achieve not less than minimum coating thickness indicated in Part 2 product listing, unless greater thickness is recommended by manufacturer. Verify thickness as work progresses.
 - a. Apply second base coat over first base coat layer and back roll to achieve not less than minimum coating thickness indicated in Part 2 product listing, unless greater thickness is recommended by manufacturer. Verify application thickness as work progresses.
 4. Allow base coat to cure prior to application of top coat.
 5. Following curing of base coat and prior to application of top coat, sand raised or exposed edges of fabric reinforcement.
- D. Top Coat: Apply top coat uniformly in a complete installation to field of roof and flashings.
1. Prime base coat prior to application of top coat if top coat is not applied within 72 hours of the base coat application, using manufacturer's recommended primer.
 2. Apply top coat to flashings extending coating up vertical surfaces and out onto horizontal surfaces 4 inches. Install top coat over field base coat and spread coating evenly.
 3. Apply top coat and back roll to achieve not less than minimum coating thickness indicated in Part 2 product listing, unless greater thickness is recommended by manufacturer. Verify application thickness as work progresses.
 4. Avoid foot traffic on new fluid-applied membrane for a minimum of 24 hours.
- E. Slip-Resistant Surfacing Topcoat: Apply second topcoat following application and curing of top coat. Locate as indicated, or as directed by OWNER/ENGINEER.
1. Prime first top coat prior to application of walkway top coat if walkway top coat is not applied within 72 hours of the first top coat application, using manufacturer's recommended primer.
 2. Apply slip resistant top coat layer and back roll to balance of coated roof area to achieve not less than minimum coating thickness indicated in Part 2 product listing, unless greater thickness is recommended by manufacturer. Verify application thickness as work progresses.
 3. Broadcast Slip-Resistant Top Coat Aggregate in wet top coat at rate indicated in Part 2 product listing or as otherwise recommended by coating manufacturer.
 - a. Back roll sand and top coat creating even dispersal of sand.

3.07 Field Quality Control

- A. Roofing Inspector: CONTRACTOR will engage a qualified, independent roofing inspector to perform roof tests and inspections and to prepare test reports.
- B. Roof Inspection: CONTRACTOR shall engage roofing system manufacturer's technical personnel to inspect roofing installation and submit report to ENGINEER. Notify ENGINEER/OWNER 48 hours in advance of dates and times of inspections. Inspect work as follows:
 - 1. Upon completion of preparation of first component of work, prior to application of re-coating materials.
 - 2. Following application of re-coating to flashings and application of base coat to field of roof.
 - 3. Upon completion of re-coating but prior to re-installation of other roofing components.
- C. Repair fluid-applied membrane where test inspections indicate that they do not comply with specified requirements.
- D. Arrange for additional inspections, at CONTRACTOR's expense, to verify compliance of replaced or additional work with specified requirements.

3.08 Protecting and Cleaning

- A. Protect roofing from damage and wear during remainder of construction period.
- B. Correct deficiencies in or remove coatings that do not comply with requirements, repair substrates, and reapply coatings.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

End of Section

Section 07 6200

Sheet Metal Flashing and Trim

Part 1 General

1.01 Section Includes

- A. Sill flashings, drip edges and formed metal trim pieces not specified elsewhere.
- B. Metal edge and preformed roof flashings.
- C. Metal Parapet Caps.

1.02 Related Sections

- A. Section 07 5323: Single-Ply Roofing – Fully Adhered
- B. Section 07 9200: Joint Sealants
- C. Section 09 9000: Painting and Coating

1.03 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 D4586 - Asphalt Roof Cement, Asbestos-Free.
- F. FS O-F-506 - Flux, Soldering, Paste and Liquid.
- G. NRCA (National Roofing CONTRACTORs Association) - Roofing Manual.
- H. SMACNA - Architectural Sheet Metal Manual.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
- C. Submit two (2) samples 6-inch x 6-inch in size illustrating metal finish color for each type for flashing to be provided.

1.05 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 (1) 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.

1.06 Qualifications

- A. Fabricator and Installer: Company specializing in sheet metal flashing work with three (3) years' documented experience.

1.07 Pre-Installation Conference

- A. Convene one (1) week prior to commencing work of this section, under provisions of Section 01 3119, Project Meetings.

1.08 Delivery, Storage, And Handling

- A. Deliver, store, protect and handle products to site under provisions of Section 01 6000, Product Requirements.
- 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.

1.09 Coordination

- A. Coordinate work under provisions of Section 01 3119, Project Meetings.
- B. Coordinate with the work of Section 07 5323, Single-Ply Roofing - Fully Adhered, for installing flashing in conjunction with roofing materials.

Part 2 Products**2.01 Manufacturers**

- A. 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:
 - 1. IMETCO, Inc.
 - 2. PAC-CLAD Peterson
 - 3. W.P. Hickman

2.02 Sheet Materials

- A. Galvanized Steel Sheet: Mill phosphatized, minimized spangle, zinc coating designation G90 per ASTM A 525.
- B. Galvanized Steel Gages: Metal gages shall be as specified below. If a fabrication is required that is not listed below, CONTRACTOR shall follow minimum SMACNA galvanized steel gage recommendations for that item. Unless noted otherwise on the Drawings, use minimum 22 gage for all items except:
 - 1. Use 24 gage for continuous cleats, reglets and counter flashings.
 - 2. Use 24 gage for gravel stop/fascias up to 5 inches high (over 5 inches use 22 gage.)
 - 3. Use 24 gage for rain gutter girth up to 20 inches; for larger girth, follow SMACNA recommended minimum gages.

5. Use 24 gage for downspouts; hanger fabrications shall be minimum 1/16" x 1" flat stock, color to match downspouts.

2.03 Accessories

- A. Fasteners: Same material and finish as flashing metal (unless noted otherwise on the Drawings), with soft neoprene washers.
- B. Sealant: Specified in Section 07 9000, Joint Sealants.
- C. Bedding Compound: Type appropriate for substrate.
- D. Plastic Cement: ASTM D4586, asbestos free.

2.04 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 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.

2.05 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 standard color as selected per approved samples.

Part 3 Execution

3.01 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.

3.02 Preparation

- A. Install starter and edge strips, and cleats before starting installation.

3.03 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.

3.04 Field Quality Control

- A. Inspection will involve ENGINEER observation of work during installation to ascertain compliance with specified requirements.

End of Section

Section 07 7233 Roof Hatches

Part 1 General

1.01 Section Includes

- A. Prefabricated roof hatches, with integral support curbs, operable hardware, safety railings and counterflashings.

1.02 Related Sections

- A. Section 06 1053.16: Wood Blocking and Curbing
- B. Section 07 6200: Sheet Metal Flashing and Trim
- C. Section 09 9000: Painting and Coating

1.03 References

- A. FM - Roof Assembly Classifications.
- B. UL - Fire Hazard Classifications.

1.04 Submittals for Review

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Product Data: Provide data on unit construction, sizes, configuration, jointing methods and locations when applicable, and attachment method.
- C. Manufacturer's Installation Instructions: Indicate special installation criteria, interface with adjacent components.

1.05 Warranty

- A. Refer to Section 01 7700, Closeout Procedures with regard to CONTRACTOR guarantee period.
- B. Hatches shall be covered by the manufacturer's 5-year warranty against defect on materials and workmanship.

Part 2 Products

2.01 Roof Hatch

- A. Manufacturers:
 - 1. Bilco Company: Model Type S.
 - 2. Milcor, Model M-1.
- B. Substitutions, Materials and Equipment: Product substitutions permitted.

2.02 General

- A. Hatches shall be designed to carry a minimum of 40 pounds per square foot live load on the covers without deflection of more than 1/240 of the span.

- B. Integral Steel Curb: 14-gage galvanized (G-90) steel with 1-inch rigid insulation; integral cap flashing to receive roof flashing; extended flange for mounting.
- C. Hatches shall have manufacturer's standard thermoplastic rubber gasketing to insure weathertightness.
- D. Hardware shall be type 316 stainless steel:
 - 1. Compression spring operator and shock absorbers;
 - 2. Steel manual pull handle for interior and exterior operation;
 - 3. Steel hold open arm with vinyl covered grip handle for easy release,
 - 4. Padlock hasp, inside and outside.
 - 5. Hinges: Heavy duty pintle type.
 - 6. Hatch finish shall be for an aggressive, damp environment.
- E. Accessories:
 - 1. Telescoping safety post shall be provided at the ladder access hatch to the roof. 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. Safety post mounts to the center of the ladder. Device shall be constructed of type 304 stainless steel.

2.03 Fabrication

- A. Fabricate components free of visual distortion or defects. Fully welded corners and joints to insure weathertightness.
- B. Provide for removal of condensation occurring within components or assembly.
- C. Fit components for weather tight assembly.

Part 3 Execution

3.01 Installation

- A. Install in accordance with manufacturer's instructions.
- B. Coordinate with installation of roofing system and related flashings for weather tight installation.
- C. Verify installation of deck edge flashing pieces prior to installation of roof hatches.
- D. Apply bituminous paint on surfaces of units in contact with cementitious materials or dissimilar metals.
- E. Adjust hinges for smooth operation.
- F. Hatch shall be cleaned and made ready for field painting.
- G. Telescoping safety hatch shall be attached to the ladder, centered between the ladder rails.

End of Section

Section 07 9200 Joint Sealants

Part 1 General

1.01 Section Includes

- A. CONTRACTOR shall furnish all materials, equipment and perform all work to complete installation of all exterior caulking at the new Building, 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.

1.02 Related Sections

- A. Section 04 2200: Concrete Unit Masonry
- B. Section 08 1213.53: Custom Steel Frames
- C. Section 08 5213: Steel Windows

1.03 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.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- 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.

1.05 Quality Assurance

- A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

1.06 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.

1.07 Environmental Requirements

- A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.08 Coordination

- A. Coordinate work under provisions of Section 01 3119, Project Meetings.
- B. Coordinate the work with all sections referencing this section.

1.09 Warranty

- A. Provide five-year warranty under provisions of Section 01 7700, Closeout Procedures.
- 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**2.01 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; Sonolastic NP-2 manufactured by Sonneborn Building Products; 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 Fahrenheit (-40 to 82 degrees Celsius)
 - 3. Shore A Hardness (After aging): 35
- 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; Sonolastic Paving Joint Sealant, manufactured by Sonneborn Building Products; Pecora Urexpam NR-200, manufactured by Pecora Corporation.
 - 1. Elongation Capability: Minimum 25 percent.
 - 2. Service Temperature Range: -40 to 150 degrees Fahrenheit (-40 to 65 degrees Celsius)
 - 3. Shore A Hardness: 30

- C. Polysulfide Sealant: Federal Specification TT-S-00227E, Type II, and ASTM C920, Grade NS, Type M, Class 25 use NT, M, A, and G; two component, non-sag polysulfide rubber sealant. Synthacalk GC2+, manufactured by Pecora Corporation; Two-part Polysulfide, manufactured by Sonneborn Building Products, or other approved equal. Polysulfide shall be used where indicated on the Contract Drawings for a specific location.
- D. 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 Contract Drawings for a specific location.

2.02 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 percent 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

3.01 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.

3.02 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.

3.03 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.

3.04 Cleaning

- A. Clean work under provisions of 01 7700, Closeout Procedures.
- B. Clean adjacent soiled surfaces.

3.05 Protection of Finished Work

- A. Protect finished installation under provisions of Section 01 5000, Temporary Facilities and Controls.
- B. Protect sealants until cured.

End of Section

Division 08
Openings

Section 08 1119.13

Custom Stainless Steel Doors And Frames

Part 1 General

1.01 Section Includes

- A. This Section includes custom-fabricated, commercial-quality stainless steel doors and frames for Stairway and Wetwell doors.

1.02 Related Sections

- A. Section 04 0511: Mortar Masonry and Grout
- B. Section 04 2200: Concrete Unit Masonry
- C. Section 08 7100: Door Hardware

1.03 Definitions

- A. Metal Thickness: Sheet metal thicknesses given in inch dimensions are nominal thicknesses and subject to tolerances as defined in the ASTM standards listed for the following materials:
- B. Stainless-Steel Sheet: ASTM A 480.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Product Data including manufacturer's specifications for fabrication and installation. Provide data substantiating that products comply with requirements.
- C. Shop Drawings showing fabrication and installation of custom steel doors and frames work. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of frame anchorage, door and frame hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items.

1.05 Quality Assurance

- A. Manufacturer Qualifications: Engage a firm experienced in manufacturing custom steel doors and frames similar to those indicated for this Project and that have a record of successful in-service performance, as well as sufficient production capacity to produce required units without delaying the Work.

1.06 Warranty

- A. Stainless steel doors and frames shall be warranted by the manufacturer to be free of defects in materials and workmanship for a period of two years from date of installation.

1.07 Delivery, Storage, and Handling

- A. Deliver doors and frames palletted, wrapped, or crated to provide protection during transit and job storage.
- B. Inspect doors and frames on delivery for damage. Minor damages may be repaired provided refinished items match new work and are acceptable to ENGINEER; otherwise, remove and replace damaged items as directed.

Part 2 Products**2.01 Manufacturers**

- A. Manufacturers: Subject to compliance with requirements, provide stainless steel doors and frames by one of the following:
 - 1. Ambico Ltd.
 - 2. Next Door Company

2.02 Materials

- A. Stainless-Steel Sheets: Commercial-quality stainless steel, Type 316.
- B. Supports and Anchors: Fabricated from not less than, 14 gage, 0.0751-inch-thick stainless steel sheet.
- C. Inserts, Bolts, and Fasteners: Manufacturer's standard stainless steel units.

2.03 Fabrication

- A. Doors and frames shall be fabricated to meet the requirements of the National Association of Architectural Metal Manufacturers Specification HMMA 862, Commercial Security Hollow Metal Doors and Frames.
- B. Doors and frames shall receive Underwriter Laboratory's labels as required and called for in the Door Schedule.
- C. Doors and frames shall be fabricated to the sizes shown in the Door Schedule.
- D. Materials used in the fabrication of the doors and frames, plates, sheets, screws, stiffeners, etc. shall be of the same material, stainless steel type 316.
- E. Fabricate doors and frames rigid, neat in appearance, and free from defects, warp, or buckle. Accurately form metal to required sizes and profiles. Where practicable, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at the Project site. Weld exposed joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
- F. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.

- G. Hardware Preparation: Prepare doors and frames to receive hardware, including cutouts, reinforcing, mortising, drilling, and tapping according to final hardware schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A115 Series specifications for door and frame preparation for hardware.
- H. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at Project site.
- I. Locate hardware as indicated or, if not indicated, according to the Hollow Metal Manufacturers Association's HMMA 830, "Hardware Preparation and Locations for Hollow Metal Doors and Frames."

2.04 Doors

- A. Stainless-Steel Doors: Fabricate stainless-steel doors of 2 outer stainless-steel sheets not less than 16-gage, 0.0625-inch-thick, permanently and continuously bonded or welded to rigid internal steel core. Construct doors with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges, except around glazed or louvered panel inserts. Provide No. 4 finish on exposed surfaces with vertical grain direction, unless otherwise shown.
- B. Provide internal core constructed of reinforced, stiffened, and sound deadened with kraft impregnated honeycomb core completely filling the door and laminated to the inside face of the panels.
- C. Reinforce doors as necessary with stainless steel plates, welded in place, for all hardware as specified under Section 08 7100, Door Hardware. Coordinate this work with the door hardware supplier. Plate thicknesses shall be the same as specified under Section 08 1213.53, Custom Steel Frames.
- D. Reinforce tops and bottoms of doors with 0.0480-inch- thick horizontal stainless steel channels, spot welded maximum 6 inches on center to core faces. Close bottom edge with stainless steel sheet 0.0480-inch-thick closing channel and top edge with same thickness stainless steel filler channel so webs of channels are flush with bottom and top edges. Seal joints in top edges of doors against water penetration.

2.05 Frames

- A. Fabricate frames of full-welded unit construction, with corners mitered, reinforced, and continuously welded full depth and width of frame. Knock-down frames are not acceptable.
- B. Stainless-steel doors frames shall be fabricated from stainless-steel sheets, 14-gage, 0.0781-inch-thick minimum, with No. 4 finish. The frames shall be industry standard 2" profile and 5-3/4" width.
- C. Hardware Reinforcement: Minimum thickness of stainless steel reinforcing plates for the following hardware:
 - 1. Hinges: 0.0751 inch thick by 1-1/2 inches wide by full length.
 - 2. Strikes, Flush Bolts, and Closers: 12 gage, 0.1054 inch .
 - 3. Surface-Mounted Hold-Open Arms and Panic Devices: 12 gage, 0.1054 inch.

- D. Jamb Anchorage: Anchor jambs to masonry with "T" anchor straps, minimum of 3 straps per jamb.
- E. Spreader Bars: Provide removable spreader bar across bottom of frames, fasten to jambs in a manner necessary not to damage the stainless steel finish.
- F. Frames shall be filled with mortar as the wall is built up, including the head.

2.06 Finishes

- A. Stainless-Steel Doors and Frames: Doors and frames shall be provided in a #4 finish.

Part 3 Execution

3.01 Installation

- A. Frames: Install custom stainless steel frames for doors, of size and profile as indicated.
 - 1. Install frames and accessories according to manufacturer's installation instructions and as specified.
 - 2. Setting Masonry Anchorage Devices: Provide masonry anchorage devices where required for securing frames to in-place concrete or masonry construction.
 - a. Remove spreader bars only after frames or bucks have been properly set and secured.
- B. Doors: Fit doors accurately in their respective frames, with the following clearances:
 - 1. Jambs and Head: 3/32 inch.
 - 2. Meeting Edges, Pairs of Doors: 1/8 inch.
 - 3. Bottom: 3/8 inch.

3.02 Adjusting and Cleaning

- A. Final Adjustments: Check and readjust operating hardware items just prior to final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including doors or frames that are warped, bowed, or otherwise unacceptable.

3.03 Protection of Finished Work

- A. CONTRACTOR shall take care to protect the finished installation of these doors. Any damage to these doors after the installation shall be CONTRACTOR's responsibility and will need to be repaired or replaced as necessary to meet OWNER's approval, at no additional cost to OWNER.

End of Section

Section 08 1213.53 Custom Steel Frames

Part 1 General

1.01 Section Includes

- A. Rated and non-rated galvanized, reinforced steel frames for hollow metal doors.

1.02 Products Furnished but Not Installed Under This Section

- A. Section 04 2200, Concrete Unit Masonry: Placement of anchors into wall construction.

1.03 Related Sections

- A. Section 04 0511: Mortar Masonry and Grout
- B. Section 08 1313.53: Custom Steel Doors
- C. Section 08 7100: Door Hardware
- D. Section 08 8000: Glazing
- E. Section 09 9000: Painting and Coating

1.04 References

- A. ASTM A653 - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
- B. DHI - Door Hardware Institute: The Installation of Commercial Steel Doors and Steel Frames, Insulated Steel Doors in Wood Frames and Builder's Hardware.
- C. HMMA 802 - Manufacturing of Hollow Metal Doors and Frames.
- D. HMMA 820 - Hollow Metal Frames.
- E. HMMA 830 - Hardware Preparation and Locations for Hollow Metal Doors and Frames.
- F. HMMA 840 - Installation and Storage of Hollow Metal Doors and Frames.
- G. HMMA 850 - Fire Rated Hollow Metal Doors and Frames.
- H. NFPA 80 - Fire Doors and Windows.
- I. NFPA 252 - Fire Tests for Door Assemblies.
- J. UL 10B - Fire Tests of Door Assemblies.

1.05 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Shop Drawings: Indicate frame elevations, reinforcement, construction and finish. Provide details for removable hollow metal transom at transom panel.
- C. Shop Drawings: Indicate the following:

1. Details of doors including vertical and horizontal edge details.
 2. Frame details for each frame type including dimensioned profiles.
 3. Details and locations of reinforcement and preparations for hardware.
 4. Details of each different wall opening condition.
 5. Details of anchorages, accessories, joints, and connections.
- D. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

1.06 Quality Assurance

- A. Conform to requirements of HMMA 802, HMMA 820, HMMA 830, HMMA 840, HMMA 850, SDI 100, ANSI A117.1 and ANSI A151.1.
- B. A physical label or approved marking shall be affixed to fire door rated frames at an authorized facility as evidence of compliance with procedures of the labeling agency.

1.07 Qualifications

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

1.08 Delivery, Storage, And Handling

- A. Deliver, store, protect, and handle products to site in accordance with the manufacturer's instructions.
- B. Protect frames with resilient packaging sealed with heat shrunk plastic.
- C. Break seal on-site to permit ventilation. If moisture appears under the shipping wrapper, remove wrapper, vent to dry and recover, allowing air to circulate around frames.
- D. Store frames upright, under cover, on 4-inch wood sills set on floors in a manner to prevent rust and damage. Provide a 1/4-inch space between frames to promote air circulation.

1.09 Field Measurements

- A. Verify that field measurements are as indicated on the shop drawings.

1.10 Coordination

- A. Coordinate work under provisions of Section 01 6000, Product Requirements.
- B. Coordinate the work with frame opening construction, door and hardware installation.

Part 2 Products

2.01 Frame Manufacturers

- A. CECO
- B. Substitutions: Under provisions of the Specifications.
 - 1. Substitutions must meet the gage and galvanizing specification requirements.
 - 2. Frames shall be from the same manufacturer as the hollow metal doors.

2.02 Frames

- A. Steel: G90 Galvanized sheet in accordance with ASTM A653.
- B. Frames: 14 gage thick material, core thickness.

2.03 Accessories

- A. Silencers: Resilient rubber fitted into drilled hole are required on all interior frames.
- B. Bituminous Coating: Fibered asphalt emulsion.
- C. Primer: Zinc chromate.
- D. Masonry jamb anchors shall be galvanized strap anchors; wire anchors are not permitted. Anchors shall be perforated to aid in the mortaring solid of frames.
 - 1. UL requirements indicate the strap anchors must be welded in place.
 - a. Coordinate placement with masonry coursing.
 - b. Touch-up galvanized coating damaged from welding prior to back-coating of frame.
- E. Where frames are to be installed in concrete walls or existing masonry walls, provide countersunk expansion anchor bolts (4 per jamb) to secure frame.
 - 1. Anchor bolt heads shall be glazed over with epoxy, flush and smooth with frame surface, primed and finish painted to match frame.
- F. Provide adjustable jamb base anchors for each frame.

2.04 Fabrication

- A. Fabricate frames to HMMA 802 and 820, style and configuration to suit doors specified in Section 08 1313.53, Custom Steel Doors.
- B. Fabricate frames with 2-inch jamb face and 2-inch head (unless noted otherwise on the Drawings); frames shall be set-up and arc welded with corner welds ground smooth.
- C. Mortise all exterior frames for 2 pairs of hinges.

- D. Fabricate frames with hardware reinforcement plates projection welded in place. All reinforcing shall be G90 galvanized. Minimum reinforcing gages:
 - 1. Strike reinforcement: 16 gage
 - 2. Hinge reinforcements: 8 gage
 - 3. Lock reinforcements: 16 gage
 - 4. Closer reinforcement: 14 gage
- E. Provide adequate reinforcing for all other hardware as may be specified.
- F. Provide mortar guard boxes.
- G. Prepare interior door frames for silencers. Provide three single silencers for single doors on strike side.
- H. Fabricate frames for heights as shown on the Drawings.

2.05 Finish

- A. Interior and Exterior Units: ASTM A653 G90.
- B. Primer: One coat, baked on, rust inhibiting paint in accordance with ANSI A224.1.
- C. Coat inside of frame profile with bituminous coating to a thickness of 1/16 inch (1.5 mm).

Part 3 Execution

3.01 Examination

- A. Verify substrate conditions under provisions of Section 01 6000, Product Requirements.
- B. Verify that opening sizes and tolerances are acceptable.

3.02 Installation

- A. Deliver frames to the Project Site for installation. Coordinate delivery staging area. Protect until installation.
- B. Install frames in accordance with HMMA 840 and HMMA 830.
- C. Install frames into new masonry walls using masonry strap anchors, minimum of 3 anchors per jamb for a standard pedestrian door (7'0" high). Provide additional anchors for taller doors to maintain a maximum spacing of 2'-0" between anchors.
- D. Install frames in concrete walls or existing masonry walls. Bolt the hollow steel frames to the wall opening edges with the "existing wall anchor assemblies". Provide one assembly each at top and bottom of jamb, not over eight inches away from end and at not over 2 feet between end assemblies, in each jamb. Countersink bolt heads to be flush with the face of the stops, through sleeved spacers behind the stops.

- E. Install frames at structural channel or plate rough openings by welding the frames to the rough opening steel. At each jamb, use four 2-inch long fillet welds at each face of frame (total of 16 welds). At head, use three 2-inch long fillet welds at each face of frame (total of 6 welds).
- F. Install Fire-Rated frames in accordance with NFPA Standard No. 80, and with the requirements of the Owner's Underwriters or the Rating Bureau, as appropriate. Install frames so that when doors are in the closed position, there are no corner or edge gaps between door and frame.
- G. Comply with provisions of SDI-105-92 "Recommended Erection Instructions for Steel Frames", unless otherwise shown.
- H. Mortar frames solid.
- I. Coordinate installation of glass and glazing.
- J. Coordinate installation of frames with installation of hardware specified in Section 08 7100 and doors in Section 08 1313.53.

3.03 Erection Tolerances

- A. Maximum Diagonal Distortion: 1/16 inch (1.5 mm) measured with straight edges, crossed corner to corner.

End of Section

Section 08 1313.53 Custom Steel Doors

Part 1 General

1.01 Section Includes

- A. Non-rated and rated galvanized metal doors, reinforced for hardware.
- B. Removable, insulated transom panel shall be the same construction as the doors.

1.02 Related Sections

- A. Section 04 0511: Concrete Unit Masonry
- B. Section 08 1213.53: Custom Steel Frames
- C. Section 08 7100: Door Hardware
- D. Section 08 8000: Glazing
- E. Section 09 9000: Painting and Coating

1.03 References

- A. ASTM A653 - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
- B. ASTM A591 - Steel Sheet, Cold Rolled, Electrolytic Zinc-Coated.
- C. Door Hardware Institute (DHI) - The Installation of Commercial Steel Doors and Steel Frames, Insulated Steel Doors and Builder's Hardware.
- D. HMMA 802 - Manufacturing of Hollow Metal Doors and Frames.
- E. HMMA 810 - Hollow Metal Doors.
- F. HMMA 830 - Hardware Preparation and Locations for Hollow Metal Doors and Frames.
- G. HMMA 840 - Installation and Storage of Hollow Metal Doors and Frames.
- H. NFPA 80 - Fire Doors and Windows.
- I. NFPA 252 - Fire Test for Door Assemblies.
- J. UL 10B - Fire Tests of Door Assemblies.
- K. ANSI A151.1 - Endurance Test.
- L. ANSI 115 - Hardware Preparation.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Door Locations and Identification: Submit shop drawings and list the location in building and identification mark for each hollow steel door and frame. Indicate door hardware requirements. Submit manufacturer's printed instructions covering installation of the specified work.

- C. Shop Drawings: Indicate the following:
 - 1. Elevations of each door design.
 - 2. Details of doors including vertical and horizontal edge details.
 - 3. Details and locations of reinforcement and preparations for hardware.
 - 4. Details of anchorages, accessories, joints, and connections.
 - 5. Coordination of glazing frames and stops with glass and glazing requirements.
- D. Door Schedule: Use same reference designations indicated on Contract Drawings in preparing schedule for doors and frames.
- E. Oversize Construction Certificates: For door assemblies required to be fire-protection rated and exceeding size limitations of labeled assemblies.

1.05 Performance Requirements

- A. Conform to requirements of HMMA 802, HMMA 810, HMMA 830, HMMA 840, HMMA 850, and ANSI A117.1.

1.06 Qualifications

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 3 years' experience.

1.07 Delivery, Storage, And Handling

- A. Wrap, carton, and crate as required to provide physical and climatic protection during loading, shipping and job site storage and handling.
- B. Deliver packaged materials to the project site in the manufacturer's original, unopened containers which bear intact, legible and visible labels that identify the manufacturer's name and brand name, the contents, grade and type.
- C. Upon delivery, immediately inspect shipments to assure their compliance with the requirements of the Contract Documents and approved submittals, and that products are complete, undamaged and adequately protected. Immediately report damaged, missing, or defective items. Remove broken, damaged or unlabeled items from the site immediately.
- D. Store doors and frames at building site under cover. Place units on minimum 4-inch-high wood blocking. Avoid use of non-vented plastic or canvas shelters which could create humidity chamber. If cardboard wrapper on door becomes wet, remove carton immediately. Provide 1/4-inch spaces between stacked doors to promote air circulation.
- E. Store products in accordance with manufacturer's instructions with seals and labels intact, legible, and visible. Store products in a manner to prevent damage, soiling, theft, deterioration and contamination. Marred surfaces, cracked, checked split or warped materials will be rejected. Store materials subject to damage by climatic conditions in weather tight enclosures. Maintain temperature and humidity within the ranges required or recommended by the manufacturer.

- F. Repair or clean items that have been damaged or soiled that can be restored to an “as new” condition at no cost to OWNER. OWNER shall be the judge of the effectiveness of remedial measures. Additional time or expenses required to secure replacements and to make repairs will not be considered by OWNER to justify an extension in the Contract time of completion or an increase in the Contract amount.

1.08 Field Measurements

- A. Field measure openings prior to fabrication of doors.
- B. Verify that field measurements are as indicated on the shop drawings.

1.09 Coordination

- A. Coordinate the work with door opening construction, door frame and door hardware installation

Part 2 Products

2.01 Door Manufacturers

- A. CECO: Product - Medallion Series.
- B. Substitutions: Under provisions of the Specifications.
 - 1. Substitution must meet the gage and galvanizing specification requirements.
 - 2. Doors shall be from the same manufacturer as the hollow metal frames.

2.02 Doors

- A. Doors (Rated and Non-rated): Flush seamless doors with glass inserts as indicated on the Contract Drawings.

2.03 Door Construction

- A. Face: Steel, 16 gage, galvanized sheet in accordance with ASTM A653, G90, galvanized both sides; manufactured and fabricated in accordance with HMMA 802 and 810.
- B. 22 gage stiffeners spaced at 6” internally on the door, welded to the face sheets at 5” on center.
- C. Core: Fiberglass insulation to limit thermal and sound transmission.
- D. Door Edge Design: 1/8 inch in 2-inch bevel, hinge and lock edges.
- E. Door Edge Seam: Doors shall have vertical, interlocking, continuous mechanical joints at lock and hinge side with edge seam filled and ground smooth to provide a seamless appearance. The internal portion of the seam shall be sealed with epoxy.
- F. Glass moldings and stops:
 - 1. Where indicated on the Drawings doors shall be provided with steel moldings to secure glazing by others in accordance with the glass sizes and thickness indicated and specified.

2. Fixed glass moldings shall be welded to the exterior side (secure side) of the door.
3. Removable glass stops shall be channels that are a minimum 20 gage with tight fitting corners and secured with countersunk philips head machine screws; provide a minimum of two screws per each length of molding; where length is more than 18 inches long, provide additional screw anchorage at not over 12 inches on center. Moldings shall be mounted flush into the door or frame without overlapping the door or frame face sheet.
4. All metal surfaces shall be galvanized similar to the door and finished to match the door primer as shipped from the factory.

2.04 Fabrication

- A. Fabricate doors with galvanized hardware reinforcement welded in place. Prepare doors to receive mortised hardware unless noted otherwise in Section 08 7100, Door Hardware.
- B. Fabricate fire doors to UL requirements for labeling as designated in the Door Schedule on the Contract Drawings. Attach fire rated label to each door unit.
- C. Close top and bottom edge of all doors with steel channel closure. Weld all seams watertight. Top of door shall be flush, bottom channel closure shall be inverted.
- D. Mortise all exterior doors for 2 pair hinges.
- E. Mortise all interior doors for 1-1/2 pair hinges.
- F. Fabricate doors with hardware reinforcement plates projection welded in place. All reinforcing shall be G90 galvanized. Minimum reinforcing gages:
 1. Hinge reinforcements: 7 gage minimum.
 2. Lock reinforcements: 16 gage minimum.
 3. Closer reinforcement: 12 gage box minimum.
- G. Provide adequate reinforcing for all other hardware as may be specified.

2.05 Finish

- A. Doors and Transom Panel: ASTM A653 G90 galvanizing.
- B. Primer: Shop applied, baked on, rust inhibited paint, compatible with galvanized surfaces.
- C. Shop primer shall be compatible with finish coats applied in the field.
- D. Doors and transom panel shall be field painted as specified in Section 09 9000; color shall be as selected by OWNER.

Part 3 Execution

3.01 Examination

- A. Verify substrate conditions are ready to receive work.

- B. Verify that opening sizes and tolerances are acceptable.

3.02 Installation

- A. Install doors in accordance with HMMA 840 and HMMA 830 DHI for hardware installation.
- B. Assemble door hardware, place accurately and attach securely to the doors and frames.
- C. Hang doors to fit closely in frames without binding; to be in full contact with stops at all points when closed; to swing easily and quietly, without striking the floor at any point of the swing; and to remain in any position left between opened and closed without moving. Exterior doors shall be weathertight when closed.
- D. Fit doors accurately in frames, within clearances specified in ANSI A250.8.
- E. Thermal insulated door perimeter seals shall be adjusted for proper operation.
- F. Coordinate installation of glass and glazing.
- G. Coordinate installation of doors with installation of frames specified in Section 08 1213.53 and hardware specified in Section 08 7100.

3.03 Erection Tolerances

- A. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.04 Field Quality Control

- A. After doors are installed, test-demonstrate in the presence of OWNER that the doors operate properly under all conditions. Adjust doors and door hardware if tests show improper functioning.

3.05 Adjusting and Cleaning

- A. Adjust door for smooth and balanced door movement.
- B. Prime Coat Touch-up: Immediately after installation, sand smooth any rested or damaged areas of prime coat and apply touch up of compatible air-drying primer.
- C. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

End of Section

Section 08 3323 Overhead Coiling Doors

Part 1 General

1.01 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 at the Grit Room is classified as Class I, Division 1, Group D environment.
 - 3. Coiling Door: Surface mounted, explosion proof operator & controls.

1.02 Related Sections:

- A. Section 09 9000: Painting and Coating
- B. Division 26, Electrical

1.03 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.

1.04 System Description

- A. Electric Operation: Electric motor operated unit with manual chain operation override in case of power failure.

1.05 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 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.

1.06 Submittals

- A. Submit under provisions of Section 01 3300, 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.

1.07 Closeout Submittals

- A. Submit under provisions of Section 01 7700, Closeout Procedures.
- B. Operation and Maintenance Data: Submit lubrication requirements and frequency, and periodic adjustments required.

Part 2 Products**2.01 Overhead Coiling Doors**

- A. Manufacturers:
 - 1. Overhead Door Corp, Model 625.
 - 2. Raynor Garage Doors, Model DuraCoil Optima.
 - 3. Wayne Dalton model similar to above.
- B. Substitutions: Section 01 2513, Substitution Procedures.

2.02 Components

- A. Curtain: Conforming to the following:
 - 1. Slats: Interlocking, flat slat construction. Outer slats to be minimum 20-gauge stainless steel, inner slats to be minimum 24-gauge stainless steel.
 - 2. Nominal Slat Size: 2 5/8 inches wide x required length.
- B. Slats shall be insulated similar to Overhead Door Corporation Model 625, CFC-free foamed in place polyurethane insulation slat with 24-gage interior steel cover sheet; minimum R-Value of 6.
 - 1. Slat Ends: Each slat fitted with end locks to act as wearing surface in guides and to prevent lateral movement.
 - 2. Windlocks: As required by Manufacturer.
 - 3. Wind Design: 20 PSF, minimum.
 - 4. Curtain Bottom: Fitted with two stainless steel angles minimum 1/8-inch thickness back to back, to provide reinforcement and positive contact with floor in closed position.

- C. Guides: Minimum 3/16-inch; stainless steel conforming to ASTM A653/A653M, minimum galvanized coating designation G90 (Z275) coating class. Wall mounted angles shall be continuous.
- D. Endlocks:
 - 1. Malleable-iron castings galvanized after fabrication, secured to curtain slats with galvanized rivets, or high-strength nylon.
 - 2. Provide locks on not less than alternate curtain slats for curtain alignment and resistance against lateral movement.
- E. Counterbalance: Steel pipe and helical steel spring system, capable of producing torque sufficient to ensure smooth operation of curtain from any position and capable of holding position at mid-travel; with adjustable spring tension.
- F. Brackets:
 - 1. Stainless steel to support counterbalance, curtain and hood.
- G. Hood Enclosure: 24-gage stainless steel; internally reinforced to maintain rigidity and shape and prime painted. Hood shall have an internal neoprene hood baffle to minimize air infiltration.
- H. 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.
- I. Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency auxiliary operator.
- J. Hardware: Door shall be fitted with a roller chain and sprocket operator for emergency operation.
- K. Weatherstripping (Exterior Assemblies): Moisture and rot proof, resilient type for complete weathertight installation.
- L. 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.

2.03 Finishes

- A. Curtain Slats and Components: Stainless Steel, No. 4 Finish.
- B. Prime painted surfaces shall have the base coat followed by a factory powder coated finish meeting the manufacturer's standard. Color shall be OWNER-selected from the complete palette of standard and custom colors available from the door manufacturer.

2.04 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 in Division 26.

Part 3 Execution**3.01 Examination**

- A. Verify opening sizes, tolerances and conditions are acceptable.

3.02 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 07 9200, Joint Sealants.
- G. Install perimeter trim and closures.

3.03 Erection Tolerances

- A. Maintain dimensional tolerances and alignment with adjacent Work.
- B. Maximum Variation From Plumb: 1/16-inch.
- C. Maximum Variation From Level: 1/16-inch.
- D. Longitudinal or Diagonal Warp: $\pm 1/8$ -inch per 10 feet straight edge.

3.04 Adjusting

- A. Adjust door, hardware and operating assemblies for smooth and noiseless operation.
- B. Test smoke activated assemblies for proper activation.

3.05 Cleaning

- A. Clean door and components.
- B. Remove labels and visible markings.

End of Section

Section 08 5123 Steel Windows

Part 1 General

1.01 Section Includes

- A. Pre-finished steel windows with fixed sash.

1.02 Products Installed but Not Furnished Under This Section

- A. Section 07 6200: Sheet Metal Flashing and Trim

1.03 Related Sections

- A. Section 07 9000: Joint Sealants
- B. Section 09 9000: Painting and Coating

1.04 References

- A. ASTM A386 - Zinc Coating (Hot Dip) on Assembled Steel Products.
- B. ASTM E330 - Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
- C. ASTM E331 - Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
- D. ASTM A525 - General Requirements for Steel Sheet, Zinc Coated (Galvanized) by the Hot Dip Process.
- E. SSPC - Steel Structures Painting Manual.
- F. SWI - The Steel Window Institute.

1.05 System Description

- A. Windows: Fixed steel framing, hot rolled sections, factory pre-finished, exterior putty glazed, anchorage with theft proof fasteners and infill panel clip attachment devices.
- B. Muntin Configuration: Refer to elevations and sections shown on the Drawings.

1.06 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Shop Drawings: Indicate opening dimensions, framed opening tolerances, framing sizes with all members dimensioned; infill panel clip fasteners shown; indicate affected related work; installation requirements and coordination with metal panel inserts.
- C. Product Data: Provide component dimensions, anchorage and fasteners, finishes, etc.
- D. Submit two (2) samples 6 x 6 inches in size illustrating window frame section, muntin section, finish surfaces.

- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.07 Qualifications

- A. Manufacturer and Installer: Company specializing in manufacturing industrial steel windows with minimum three years documented experience.

1.08 Delivery, Storage, And Handling

- A. Deliver, store, protect and handle products to site under provisions of Section 01 6000, Product Requirements.
- B. Protect pre-finished surfaces with protective, strippable coating. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather.

1.09 Environmental Requirements

- A. Do not install sealants when ambient temperature is less than 40 degrees Fahrenheit or as recommended by sealant manufacturer.
- B. Maintain this minimum temperature during and after installation of sealants.

1.10 Field Measurements

- A. Verify that field measurements are as indicated on shop drawings.

Part 2 Products

2.01 Manufacturers

- A. A & S Window Associates
- B. William Bayley Company
- C. Substitutions shall adhere to Section 01 2513, Substitution Procedures.

2.02 Materials

- A. Steel: Hot roll formed sash sections, minimum 3.5 lb/lin ft hot dip galvanized to 2.0 oz/sq ft in accordance with ASTM A386.
- B. Fasteners: Hot dipped, galvanized steel.
- C. Shop and Touch-Up Primer for Steel Components: Specified in Section 09 9000, Painting and Coating.

2.03 Components

- A. Frames: Maximum 2-inch-deep profile, 1-inch wide exposed face, 1/8-inch thick, non-thermally broken; theft proof screw fastened, four sides, typical.
- B. Muntins: Minimum 1-3/4-inch deep inch profile, 1-inch wide sight line flange, minimum 1/8-inch thick, of shaped steel structural section.
- C. Framing and muntin configuration shall be as detailed on the Drawings.

2.04 Sealant Materials

- A. Sealant and Backing Materials: Specified in Section 07 9000, Joint Sealants.

2.05 Fabrication

- A. Fabricate components with minimum clearances and shim spacing around perimeter of assembly yet enabling installation and dynamic movement of perimeter seal.
- B. Accurately fit and secure joints and corners. Make joints flush and hairline.
- C. Prepare components to receive anchor devices. Fabricate anchors.
- D. Arrange fasteners to conceal from view.
- E. Prepare components with reinforcement for operating hardware.
- F. Provide concealed drainage weep holes to migrate moisture to exterior at the sill.

2.06 Finishes

- A. Window Frame Surface: Galvanized material, with manufacturer's standard baked on primer and premium 70% Kynar fluoropolymer, (or other OWNER-approved), fade and chip resistant finish coat. Color shall be Owner selected.
- B. Concealed Steel Items: Galvanized in accordance with ASTM A386 to 2.0 oz/sq ft.
- C. Apply one coat of bituminous paint to concealed aluminum and steel surfaces in contact with cementitious or dissimilar materials.

Part 3 Execution**3.01 Examination**

- A. Verify site opening conditions.
- B. Verify wall openings and adjoining materials are ready to receive work of this Section.

3.02 Installation

- A. Install window frames in accordance with manufacturer's instructions.
- B. Attach window frame and shims to perimeter opening to accommodate construction tolerances and other irregularities.
- C. Align window plumb and level, free of warp or twist. Maintain dimensional tolerances, aligning with adjacent work.
- D. Install sill flashings and trim.
- E. Install perimeter sealant accordance with Section 07 9000, Joint Sealants.

3.03 Tolerances

- A. Maximum Variation from Level or Plumb: 0.06-inches every 3 feet (non-cumulative), or 1/16-inches per 10 feet, whichever is less.

3.04 Adjusting

- A. Adjust work under provisions of Section 01 7700, Closeout Procedures.

3.05 Cleaning

- A. Clean work under provisions of Section 01 7700, Closeout Procedures.
- B. Remove protective material from pre-finished surfaces.
- C. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.
- D. Remove excess sealant by method acceptable to sealant manufacturer.

End of Section

Section 08 7100 Door Hardware

Part 1 General

1.01 Section Includes

- A. Hardware for hollow steel doors.
- B. Thresholds.
- C. Weatherstripping, seals and door gaskets.

1.02 Related Sections

- A. Section 08 1313.53: Custom Steel Doors
- B. Section 08 1213.53: Custom Steel Frames
- C. Section 08 1119: Stainless Steel Doors and Frames

1.03 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.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- 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.

1.05 Project Record Documents

- A. Submit under provisions of Section 01 7700, Closeout Procedures.
- B. Record actual locations of installed cylinders and their master key code.

1.06 Operation and Maintenance Data

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.

1.07 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.

1.08 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.

1.09 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 01 6000, Product Requirements.
- 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.

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 01 6000, Product Requirements.
- B. Warranty: Include coverage for door closers.

1.13 Maintenance Materials

- A. Provide maintenance materials under provisions of Section 01 6000, Product Requirements.
- 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**2.01 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. 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.
 - 2. Hinges shall be 4-1/2" x 4-1/2" minimum 0.180 inches thick stainless steel with stainless steel pins.
 - 3. Interior doors shall have a minimum of 1-1/2 pair per leaf, (U.N.O.).
 - 4. Exterior doors shall have 2 pair, (U.N.O.).
 - 5. Exterior doors shall have non-removable pins (NRP).
- C. Mortise Locks:
 - 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 construction to resist corrosion, including non-ferrous or stainless steel case.

2. Cylinder locks or unlocks outside lever. 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.

D. Levers and Escutcheons:

1. Levers shall be cast stainless steel; escutcheons shall be wrought stainless steel.
2. Each lockset set shall be furnished complete with one pair of levers and escutcheons.
3. Model shall be Corbin/Russwin "ASP".

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. 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.

G. Kickplates:

1. Dull stainless steel (US32D), (.050) gauge 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 push side of all hollow metal doors.

H. 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.

I. Weatherstripping:

1. Durable Products, National Guard Products, Reese, Zero or Pemco.
2. Model No. listed are National Guard Products (NGP).
3. Head and jambs, NGP
4. No. 160VA vinyl; door bottom seal, NGP 35E, vinyl (1/2 inch); Finish for weatherstripping shall be natural satin anodized aluminum.
5. Provide weatherstrip for all exterior doors.

J. Lock Protectors

1. All single exterior pedestrian doors shall be provided with lock protectors similar to Glynn Johnson LP series in stainless steel.
2. Coordinate exact model with door exit devices to insure proper clearances.

K. Substitutions: Under provisions of Section 01 2513, Substitution Procedures.

2.02 Keying

- A. All locks shall be capable of accepting minimum six (6) pin cores and cylinders matching OWNER's present system, master keyed to OWNER's approved system.
- B. Supply keys in the following quantities:

1. 4 keys per cylinders, plus:
 - a. 4 master keys.
 - b. 4 grand master keys.

2.03 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

3.01 Examination

- A. Verify site conditions under provisions of Section 01 1100, Summary of Work.
- B. Verify that doors and frames are ready to receive work and dimensions are as indicated on shop drawings and instructed by the manufacturer.

3.02 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.

3.03 Field Quality Control

- A. Field inspection will be performed under provisions of Section 01 4500, Quality Control.
- 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.

3.04 Adjusting

- A. Adjust work under provisions of Section 01 7700, Closeout Procedures.
- B. Adjust hardware for smooth operation.

3.05 Protection of Finished Work

- A. Protect finished Work.
- B. Do not permit adjacent work to damage hardware or finish.

3.06 Schedule

A. Set 1:

1. Hinge – 2 Pair
2. Closer H90
3. Mortise Lockset
4. Exit Device
5. Lock Protector
6. Kickplate
7. Weatherstripping
8. Threshold

End of Section

Section 08 8000 Glazing

Part 1 General

1.01 Section Includes

- A. Glass and glazing for hollow metal work.

1.02 Related Sections

- A. Section 07 9200: Joint Sealants
- B. Section 08 5213: Steel Windows

1.03 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.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Certificates: Certify that Products meet or exceed specified requirements.

1.05 Quality Assurance

- A. Installer Qualifications: Company specializing in performing the work of this section with three years' experience.

1.06 Environmental Requirements

- A. Submit under provisions of Section 01 6000, Product Requirements.
- B. Do not install glazing when ambient temperature is less than 50 degrees Fahrenheit (10 degrees Celsius).
- C. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.07 Warranty

- A. Submit under provisions of Section 01 7700, Closeout Procedures.

Part 2 Products

2.01 Glass

- A. 5/16" (8mm) thick laminated fire-rated and impact safety-rated glazing material. Rating shall comply with scheduled requirements.

2.02 Glass Manufacturers

- A. Guardian Industries
- B. PPG
- C. Tempglass Inc.
- D. Substitutions: Refer to Section 01 2513, Substitution Procedures.

2.03 Glazing

- A. Sash manufacturer's standard dry system using flexible gasket and silicone cap bead.

Part 3 Execution**3.01 Examination**

- A. Verify that openings for glazing are correctly sized and within tolerance.
- B. 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.

3.02 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.

3.03 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.

3.04 Field Quality Control

- A. Field inspection will be performed under provisions of Section 01 4500, Quality Control. Inspection will monitor quality of glazing.

3.05 Cleaning

- A. Clean work under provisions of Section 01 7700, Closeout Procedures.
- B. Remove glazing materials from finish surfaces.
- C. Remove labels after Work is complete.
- D. Clean glass and adjacent surfaces.

3.06 Protection of Finished Work

- A. Protect finished work in accordance with Section 01 7700, Closeout Procedures.
- B. After installation, mark pane with an 'X' by using removable plastic tape or paste.

End of Section

Section 08 9000 Louvers and Vents

Part 1 General

1.01 Scope of Work

- A. Provide louvers capable of withstanding the effects of wind and normal thermal movement without evidencing permanent deformation of blades, frames, and supports; noise or metal fatigue caused by louver blade rattle or flutter; or permanent damage to fasteners and anchors.
- B. Wind Load: Uniform pressure (velocity pressure) of 20 lbf/sq. ft. (960 Pa), acting inward or outward.
- C. Thermal Movements: Movements resulting from 120 degrees Fahrenheit (67 degrees Celsius) change (range) in ambient and 180 degrees Fahrenheit (100 degrees Celsius) change in surface temperatures.
- D. Maximum Standard Airflow Rating: Provide louvers with specified airflow at point of beginning water penetration through a louver 48 inches (1220 mm) wide by 48 inches (1220 mm) high (maximum standard airflow), as demonstrated by testing according to AMCA 500.

1.02 Submittals

- A. In addition to Product Data, submit the following:
 - 1. Shop Drawings: For louver units and accessories not completely described in Product Data.
 - 2. Samples of each type of metal finish.
 - 3. Product test reports indicating compliance of products with requirements.
 - 4. Manufacturers color charts showing the full range of colors, textures and patterns available.
- B. Field Measurements: Verify louver openings by field measurements before fabrication.

Part 2 Products

2.01 Manufacturers

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Airolite Co.
 - 2. All-Lite Louver Co.
 - 3. American Warming and Ventilating, Inc.
 - 4. Arrow United Industries.
 - 5. Construction Specialties, Inc.
 - 6. Greenheck Fan Corporation.
 - 7. Hart & Cooley, Inc.; Reliable Metal Products Division.
 - 8. NCA Manufacturing, Inc.

2.02 Materials

- A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy 6063-T5 or T-52.
- B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy 3003 or 5005 with temper as required for forming.
- C. Fasteners: Of same basic metal and alloy as fastened metal or 300 series stainless steel. Do not use metals that are incompatible with joined materials.
- D. Bituminous Paint: Asphalt mastic complying with SSPC-Paint 12 but containing no asbestos fibers, or asphalt emulsion complying with ASTM D 1187.

2.03 Fabrication

- A. General: Fabricate louvers to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining materials' tolerances, and perimeter sealant joints.
- B. Join frame members to one another and to fixed louver blades with fillet welds concealed from view.
- C. Join frame members to one another and to fixed louver blades with fillet welds concealed from view, threaded fasteners, or both, as standard with louver manufacturer.
- D. Fixed, Extruded-Aluminum, Horizontal Louvers: Provide louvers with extruded-aluminum frames and blades.
 - 1. Frame and Blade Thickness: 0.125 inch (3.18 mm).

2.04 Performance Requirements

- A. Drainable blade type with maximum standard airflow not less than 7500 cfm (3540 L/s) with not more than 0.18-inch wg (45-Pa) static-pressure loss.
- B. Descriptive Requirements: As follows:
 - 1. Blade Profile: Drainable blade.
 - 2. Blade Angle and Spacing: 45 degrees and 4 inches (100 mm) o.c. for 4-inch- (100-mm-) deep louvers.
- C. Louver Screens: Provide screens on interior faces of exterior louvers.
 - 1. Frames: Same kind and form of metal as indicated for louvers to which screens are attached.
 - 2. Louver Screening: As follows:
 - a. Bird Screening: Aluminum, 1/2-inch- (12.7-mm-) square mesh, 0.063-inch (1.6-mm) wire.

2.05 Finishes

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Finish louvers after assembly.

- B. Aluminum Finishes: Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.
 - 1. Class I, Color Anodic Finish: AA-M12C22A42/A44 complying with AAMA 606.1 or AAMA 608.1.
 - 2. Color: As selected by Architect from the full range of industry colors and color densities.

Part 3 Execution

3.01 General

- A. Locate and place louver units level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weather tight connection.
- C. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- D. Repair damaged finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
- E. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

End of Section

Division 09
Finishes

Section 09 1000

Piping Identification Systems

Part 1 General

1.01 Scope of Work

- A. CONTRACTOR shall furnish, mark, and install identification devices for exposed piping and piping in accessible chases and areas above ceilings with panels, and valves using color bands, lettering, flow direction arrows, and related permanent identification devices, and appurtenant works, in accordance with the requirements of the Contract Documents.

1.02 Related Work Specified Elsewhere

- A. Section 09 9000: Painting and Coating
- B. Division 22: Plumbing
- C. Division 23: Heating, Ventilating and Air-Conditioning
- D. Division 26: Electrical
- E. Division 41: Material Process and Handling Equipment
- F. Division 46: Water and Wastewater Equipment

1.03 Submittals

- A. In accordance with Section 01 3300, CONTRACTOR shall submit samples of all types of identification devices to be used in the work. CONTRACTOR shall also submit to ENGINEER, for approval, a list of suggested wording for all valve tags prior to fabrication.

Part 2 Products

2.01 Identification of Piping

- A. Exposed piping, piping in accessible chases, and piping in areas above ceilings with panels, shall be completely and totally painted for identification purposes.
 - 1. Piping shall be identified with lettering or tags designating the service of each piping system, shall have flow directional arrows, and shall be completely painted and color coded as scheduled below.
 - 2. Piping scheduled to be color coded shall be completely painted or coated with the indicated colors.
- B. Each pipe identification shall consist of 1) color coding in accordance with the Piping Identification Schedule; 2) a painted label; and 3) and a directional flow arrow. The painted label and directional arrow shall be placed between color bands. When more than one color band is used the different color bands shall be painted adjacent. Piping identification shall be located in accordance with Article 3.03 of this Section.
- C. Color Bands and Arrows:

1. Pipe color bands shall be painted on the pipe. Paper or plastic banding of pipe shall not be acceptable.
2. Arrows shall be of the same color as the lettering and shall point away from the lettered labels in the direction of the flow.
3. Color band size shall be as follows:

Pipe Size (Outside Diameter)	Color Band Width
< 1"	1"
1" - 12"	1 pipe diameter
> 12"	12"

D. Lettering:

1. Contents identification labels shall be stenciled directly on pipes.
2. Black identification letters shall be used where the background pipe color is light, and white identification letters where the background color is dark.
3. The size of the letters for identification labels shall be as follows:

Pipe Size (Outside Diameter)	Letter Size
5/8" - 1"	5/16" high
1" - 3"	3/4" high
> 3"	2"

2.02 Existing Identification Systems

- A. In installations where existing piping identification systems have been established, CONTRACTOR shall continue to use the existing system. Where existing identification systems are incomplete, utilize the existing system as far as practical and supplement with the specified system. The objective is to fully identify all new piping, valves and appurtenances to the level specified herein.

2.03 Identification of Valves and Short Pipe Lengths

- A. Identifying devices for valves and the sections of pipe that are too short to be identified with color bands, lettered labels, and arrows shall be identified with metal tags as specified herein.
- B. Metal tags shall be of stainless steel with embossed lettering. Tags shall be designed to be firmly attached to the valves or short pipes or to the structure immediately adjacent to such valves or short pipes.

2.04 Identification of Pipe 5/8 Inch or Smaller

- A. Where the outside diameter of pipe or pipe covering is 5/8 inch or smaller, metal tags shall be provided instead of lettering.
- B. Tags shall have the specified identifying lettering stamped in the tag and shall be fastened to the pipe with suitable chains.
- C. Metal tags and chains shall be aluminum or stainless steel.

- D. Where tags are used, pipe shall be color coded as specified in Article 3.04 of this Section.

2.05 Miscellaneous

- A. Electrical conduit shall be painted to match ceiling or wall surfaces as directed by ENGINEER.
- B. Vent lines shall be painted to match the surfaces that they adjoin.
- C. Valve handwheels and levers shall be painted red.
- D. Hoist hooks and blocks shall be painted yellow with black stripes.

Part 3 Execution

3.01 General

- A. Labels and identification tags shall be installed in accordance with the manufacturer's printed instructions, and shall be neat and uniform in appearance. All such tags or labels shall be readily visible from all normal working locations.

3.02 Valve Tags

- A. Valve tags shall be permanently attached to the valve or structure by means of 2 stainless steel bolts or screws.

3.03 Pipe Identification Location

- A. Straight lines of pipe shall be identified at intervals of 30 feet maximum, and at least once in each room unless otherwise directed by the Engineer.
- B. Piping shall also be identified at a point approximately within 2 feet of all turns, ells, valves, and on the upstream side of all distribution fittings or branches and on both sides of each floor, wall or barrier through which the line passes.
- C. For pipe runs of 50 feet or less the distance between bands shall be 30 inches. For pipe runs of 50 feet or more, spacing between bands shall be 72 inches.
- D. Sections of pipe that are too short to be identified with color bands, lettered labels, and directional arrows shall be tagged and identified similar to valves.

3.04 Identification Schedule

- A. Application of identifying devices shall conform to the following color codes, or match existing color code as directed by ENGINEER.

Type of Service	Pipe Color / Strip Color
<i>Domestic Water</i>	
Potable Water (RP Device)	Light Blue
Fresh Water (Air Gap)	Light Blue

Continued on the Next Page

Type of Service	Pipe Color / Strip Color
<i>Industrial and/or Cooling Water</i>	
LPE	Dark Blue/Red
MPE	Dark Blue/Red
HPE	Dark Blue/Red
HPE (continuously chlorinated)	Dark Blue/Red/Yellow
Fire Water	Red
Industrial Water	Dark Blue
Cooling Water Supply-Plant Effluent	Dark Blue/Red
Cooling Water Return-Plant Effluent	Dark Blue/Red
Cooling Water Return-Industrial Water	Dark Blue
Cooling Water Supply-Industrial Water	Dark Blue
Reclaimed Water	Purple
Final Effluent	Dark Blue/Red
Irrigation (continuously chlorinated eff.)	Dark Blue/Red/Yellow
<i>Chemical Supply Lines (Extremely Dangerous)</i>	
Chlorine (gas or liquid)	Yellow
Chlorine Solution	Yellow
Sodium Hydroxide	Yellow
Chlorinator Vent and Detection Lines	Yellow
Hydrazine	Yellow
Lime Slurry	Yellow
Sodium Hypochlorite	Yellow
Ferric Chloride	Yellow
Ferrous Chloride	Yellow
Phosphoric Acid	Yellow
Concentrated Sulfuric Acid	Yellow
Dilute Sulfuric Acid	Yellow
Chemical Draw and Vent	same color as the chemical line
Dilute Acid	Yellow
<i>Chemical Supply Lines</i>	
Anionic Polymer	White/Yellow
Cationic Polymer	White/Yellow
Nonionic Polymer	White/Yellow
Chemical Draw and Vent	same color as the chemical line
Sulfite/Bisulfite Scrubbing Liquid	White/Yellow
Stratford Solution (Scrubbing Liquor)	White/Yellow
<i>Sludge/Ash Transport and Process Lines</i>	
Blended Sludge	Dark Brown
Bottom Sludge	Dark Brown
Centrate (from digested sludge dewatering)	Dark Brown/Dark Blue
Centrate (H ₂ S Scrubbing)	White/Yellow
Circulated Sludge	Dark Brown
Digested Sludge	Dark Brown
Sulfur Slurry (H ₂ S Scrubber)	Dark Brown

Type of Service	Pipe Color / Strip Color
<i>Sludge/Ash Transport and Process Lines</i>	
Sludge Filtrate Dark	Brown/Dark Blue
Raw Sludge	Dark Brown
Screened Digested Sludge	Dark Brown
Waste Activated Sludge	Light Brown
Digester Cleanings	Dark Brown
Digested Sludge to Screenings	Dark Brown
Digested Sludge to Blending Tanks	Dark Brown
Digested Sludge Recirculated/Transfer	Dark Brown
Digested Sludge Withdrawal	Dark Brown
Thickened Waste Activated Sludge	Light Brown
Return Activated Sludge	Light Brown
Thickener Subnatant Light	Brown/Dark Blue
Thickener Subnatant Overflow	Light Brown/Dark Blue
Cyclone Effluent	Dark Brown/Dark Blue
Grit	Dark Brown
Mixed Liquor	Light Brown
Thickener Pressurized Recycle	Light Brown/Dark Blue
Scum	Dark Brown
Ash (hydraulic)	Light Brown
Processed Condensate	Dark Blue/Light Brown
Process Effluent	Dark Blue/Red
Final Clarifier Influent	Light Brown
<i>Pneumatic Transport Lines</i>	
Sludge Derived Fuel	Light Green/Orange
Hot Ash	Light Green/Yellow
Sand Transport	Light Green
<i>Air and Vacuum Supply Lines</i>	
Oxygen (gaseous)	Purple/Black
Oxygen (liquid)	Purple/Black
Combustion Air	Green
Compressed Air (non-instrument)	Green/Red
Instrument Air	Green/White
Process Air	Green
Product Air	Green/Light Green
Foul Air	Green/Grey
Nitrogen (liquid)	Green/Black
Nitrogen (gaseous)	Green/Black
Vacuum	Green
Vent Duct	same as line color
<i>Boiler Waters</i>	
Boiler Feedwater Makeup	Dark Blue/Orange
Boiler Feedwater	Dark Blue/Orange
Continuous Blow-down	Dark Blue/Orange

Type of Service	Pipe Color / Strip Color
<i>Boiler Waters... continued</i>	
Demineralized Water	Dark Blue/Orange
H. P. Condensate	Dark Blue/Orange
L. P. Condensate	Dark Blue/Orange
M. P. Condensate	Dark Blue/Orange
Intermittent Blow-down	Dark Blue/Orange
Softened Water Dark	Blue/Yellow
Reverse Osmosis Treated Water (permeate)	Dark Blue/Orange
<i>Steam</i>	
Low-pressure Steam	Orange/Red
Medium-pressure Steam	Orange/Red
High-pressure Steam	Orange/Red
<i>Lube and Hydraulic Oils</i>	
Hydraulic Oil Supply	White/Orange
Hydraulic Oil Return	White/Orange
Lube Oil	White/Orange
Drain Oil	White/Orange
Oil Vapor	White/Orange
Grease	White/Orange
Defoamant-Sludge Blending Tanks (Kerosene)	White/Orange
<i>Fuel Supply</i>	
Natural Gas/LNG/Propane	Orange
Digester Gas: LP, MP, and HP	Orange
Diesel	Orange
<i>Laboratory</i>	
Distilled Water	Dark Blue/Orange
<i>Miscellaneous</i>	
Equipment Vent	same as equipment
Sample Line	same as line or equipment being sampled
Spare Chemical	same as chemical
<i>Sanitary Sewer/Storm Drains</i>	
Roof Drain	Black or same color as bldg walls
Plant Drain	Black
Storm Drain	Black
Sump Pump Discharge	Black
Sanitary Sewer	Black
Sanitary Vent	Black
Influent Raw Sewage (up to primary tanks)	Grey
Demineralized Waste	Black/Yellow
Reverse Osmosis Reject	Black

End of Section

Section 09 9000 Painting and Coating

Part 1 General

1.01 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.

1.02 Related Sections

- A. Section 04 2200: Concrete Masonry and Grout
- B. Section 08 1213.53: Custom Steel Frames
- C. Section 08 1313.53: Custom Steel Doors

1.03 References

- A. ASTM D16 - Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products.
- B. AWWA (American Water Works Association) - D102 - Painting Steel Water Storage Tanks.
- C. International Concrete Repair Institute (ICRI) Guideline No. 310.2-1997 - 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.

1.04 Definitions

- A. Conform to ASTM D16 for interpretation of terms used in this Section.

1.05 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- 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.

1.01 Qualifications

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section and one of the four companies listed.
- B. Applicator: Company specializing in performing the work of this section with minimum three years, approved by manufacturer.

1.02 Delivery, Storage and Handling

- A. Deliver, store, protect and handle products to site under provisions of Section 01 6000, Product Requirements.
- 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 Fahrenheit (7 degrees Celsius) and a maximum of 90 degrees Fahrenheit (32 degrees Celsius), 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.

1.03 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 foot candles (860 lx) measured mid-height at substrate surface during coating operations in the area being painted.

1.04 Surfaces Not Requiring Painting

- A. Aluminum.
- B. Stainless Steel.
- C. FRP Doors and Frames.
- D. PVC and Fiberglass Pipe and Ductwork.
- E. Inside of pipe spaces, duct shafts, and similar areas not exposed to view.
- F. Exterior galvanized grating or checkered plate need not be painted, except to meet MIOSHA requirements.

Part 2 Products

2.01 Manufacturers

- A. Manufacturers - Paint and Special Coatings
 - 1. Tnemec Company
 - 2. Carboline Company
 - 3. Sherwin-Williams Company
 - 4. PPG/Amercoat
- B. Substitutions: No substitutions are allowed.
- C. Products used on this project shall be from the same manufacturer unless written authorization is received from ENGINEER.

2.02 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.

2.03 Finishes

- A. Refer to schedule at end of section for surface finish schedule.
- B. Colors will be selected by OWNER from color samples submitted.

Part 3 Execution

3.01 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 D4263 and, if necessary, F1869.

3.02 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. Impervious 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 OWNER approved epoxy/sealer (Tnemec Series N69 or Carboline Rustbond penetrating sealer; or Sherwin-Williams Macropoxy 646 or Amerlock sealer) 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. 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 canvas and cotton.
- H. Fiberglass and PVC 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 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-15.
 - 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 Fahrenheit.
3. An alternate cleaning method of phosphating may be utilized if a detailed procedure is submitted for approval prior to the start of work.
4. Cleaned surfaces shall not remain overnight without a prime coat.
5. Galvanize metal primer shall be Tnemec, Tneme-Zinc 90G, Carboline, Carbozinc 859 Primer, Sherwin-Williams DTM Wash Primer or Amercoat 68MCZ.

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 paints containing zinc dust.
 - 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 90-97 Tneme-Zinc, Carbozinc 11 HSN Carboline, Sherwin-Williams Zinc Clad 5 (aerosol), Amercoat 68MCZ or ZRC product with 95% pure zinc dust.
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 Scheduled to Receive Paint Finish:

1. Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter.
2. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry.
3. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water.
4. Allow to dry.
5. Application of block filler will be by roller or brush.
6. Spraying will not be allowed.

L. Uncoated Steel and Iron Surfaces:

1. Remove grease, dirt, and other visible contaminants by washing with solvent (SSPC-SP-1).

2. Where mill scale, weld spatter, and rust are evident, remove by power tool wire brushing (SSPC-SP-3) or where required, abrasive blast cleaning (SSPC-SP-10 or SSPC-SP-6).
 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. 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.

3.03 Application

- A. Apply products in accordance with manufacturer's instructions.
- B. Do not apply finishes to surfaces that are not dry.
- C. Apply each coat to uniform finish.
- D. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.
- E. Vacuum clean surfaces free of loose particles and/or use tack cloth just prior to applying next coat.
- F. Allow applied coat to dry before next coat is applied.
- G. 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 DTM Acyclic or PPG Pitt-Tech DTM Enamel 90-374 Series which complies with the Color Code prescribed herein.
- H. Material labels and accompanying direction of flow arrows shall be applied to all distribution mains on maximum spacing of 50 feet.
 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. 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 OWNER's approved background color in full or abbreviated, to meet OWNER's requirements and print the width of the label.
- I. 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.
 - J. 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 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.
 - K. Hazardous areas, moving machinery, handrails, and all other similar areas shall be finished to agree with OWNER's Standard Safety Code and all MIOSHA requirements, as approved by OWNER.

3.04 Finishing Mechanical and Electrical Equipment

- A. Refer to Division 26 Electrical 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.
- B. Paint shop primed equipment.
- C. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- D. Prime and paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports.
- E. Paint dampers exposed behind louvers, grilles, to match face panels.
- F. Paint exposed conduit and electrical equipment occurring in painted areas.
- G. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.
- H. 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.

- I. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.05 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. Reports shall be available to OWNER and OWNER's representative upon request at the site.
 - 5. Copies of these daily reports shall be submitted with each Payment Application for painting and coating work performed on this project for the period that is covered by the Payment Application.
 - 6. Failure to submit reports 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 01 4500.
- 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 OWNER.
 - 1. Repair areas shall be to a suitable area boundary as determined by 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.

3.06 Cleaning

- A. Clean work under provisions of 01 7700, Closeout Procedures.
- B. Collect waste material which may constitute a fire hazard, 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.

3.07 Schedule - All Interior and Exterior Surfaces

Paint System	Surfaces
1	Exterior Ferrous Metals.
2	Ferrous Metals, Piping and Equipment Located Indoors (not specified elsewhere).
3A	Interior Masonry units.
3B	Interior exposed precast and poured in place concrete, including interior concrete wall surfaces below grade (not specified elsewhere).
6	Submerged Ferrous Mechanical Equipment Components and piping, unless otherwise noted.

- A. CONTRACTOR shall note that PVC/fiberglass designation painting in addition to lightly sanding and wipe off with approved thinner solution shall consist of two coats of finish specified under Painting System No. 2 for the area to receive the identification.
- B. 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.
- C. Aluminum Surfaces shall be backcoated with an OWNER approved epoxy/sealer. Refer to Section 3.2.E of this Painting Specification.

3.08 Painting - Systems

(CONTRACTOR shall refer to Products Section herein with regard to acceptable material manufacturers.)

- A. Painting System No. 1 - Exterior Ferrous Metals Surface Preparation - SSPC-SP 6

See Paint System No. 1 on Next Page

Layer	Min. No. of Coats per Coating Layer	Product Name	Min. Total Thickness of Coating Layer Dry	Type
Primer	1	Tnemec Series N69	3.0	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 890	3.0	Cycloaliphatic Amine Epoxy
Intermediate	1	Carboline 890	4.0	Cycloaliphatic Amine Epoxy
Finish	1	Carboline 134 HG	3.0	Aliphatic/Polyurethane
Primer	1	Sherwin-Williams Macropoxy 646	3.0	Epoxy
Intermediate	1	Sherwin-Williams Macropoxy 646	4.0	Epoxy
Finish	1	Sherwin-Williams Acrolon 218 Or Hi-Solids Polyurethane	3.0	Aliphatic/Polyurethane
Primer	1	PPG Amerlock 2/400	4.0	Polyamide Epoxy
Intermediate	1	PPG Amerlock 2/400	4.0	Polyamide Epoxy Aliphatic
Finish	1	PPG Amershield	4.0	Polyurethane
CONTRACTOR shall choose one of Primer-Intermediate-Finish systems listed above. Total Thickness of System – 10.0/12.0 Dry Mils Min. CONTRACTOR shall note curing times required between coats, per actual product used.				

- B. Painting System No. 2 - Ferrous Metals, Piping and Equipment Located Indoors Surface Preparation - SSPC-SP 6.

See Paint System No. 2 on Next Page

Layer	Min. No. of Coats per Coating Layer	Product Name	Min. Total Thickness of Coating Layer Dry	Type
Primer	1	Tnemec Series N69 Epoxoline	3.0	Epoxy
Finish	2	Tnemec Series N69 Epoxoline	8.0	Epoxy
Primer	1	Carboline 890	3.0	Cycloaliphatic Amine Epoxy
Finish	2	Carboline 890	8.0	Cycloaliphatic Amine Epoxy
Primer	1	Sherwin-Williams Macropoxy 646	3.0	Epoxy
Finish	2	Sherwin-Williams Macropoxy 646	8.0	Epoxy
Primer	1	PPG Amerlock 2/400	4.0	Polyamide Epoxy
Finish	2	PPG Amerlock 2/400	8.0	Polyamide Epoxy
CONTRACTOR shall choose one of Primer-Finish systems listed above. Total Thickness of System – 11.0 Dry Mils Min.				

C. Painting System No. 3A - Interior Masonry Units Surface Preparation - SSPC-SP 13/NACE 6.

Layer	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 Hi-Build Epoxoline II	4.0	Epoxy
Finish	1	Tnemec Series N69 Hi-Build Epoxoline II	4.0	Epoxy
Undercoat	1	Carboline Sanitile 500 Block Filler	60-100 s.f. gal.	Water Based Epoxy Filler
Primer	1	Carboline 890	4.0	Cycloaliphatic Amine Epoxy
Finish	1	Carboline 890	4.0	Cycloaliphatic 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	Epoxy
Finish	1	Sherwin-Williams Macropoxy 646	4.0	Epoxy
Primer	1	PPG Amerlock 400BF	60-100 s.f.	Epoxy Masonry Block Filler
Intermediate	1	PPG Amerlock 2/400	4.0	Polyamide Epoxy
Finish	1	PPG Amerlock 2/400	4.0	Polyamide Epoxy
CONTRACTOR shall choose one of Undercoat-Primer-Finish/ Primer-Intermediate-Finish systems listed above. Total Thickness of System – 8.0 Dry Mils Minimum over filled surface.				

- D. Painting System No. 3B - Interior exposed precast and poured in place concrete Surface Preparation - Same as above
1. Primer and Finish - Same as above, but without Undercoat
 2. Total Thickness of System – 8.0 Dry Mils Min.
- E. Painting System No. 6 - Submerged Ferrous Mechanical Equipment Components and piping (non-potable) Surface preparation - SSPC-SP10

Layer	Min. No. of Coats per Coating Layer	Product Name	Min. Total Thickness of Coating Layer Dry	Type
Finish	1	Hi-Build Tneme – Tar 46H - 413	16.0	Coal Tar Epoxy
Finish	1	Carboline Bitumastic No. 50	16.0	Coal Tar Epoxy
Finish	1	Sherwin-Williams Targuard	16.0	Epoxy
Finish	1	PPG Amercoat 78HB	16.0	Coll Tar Epoxy
Total Thickness of System – 16 Dry Mils Min.				

Schedules on Next Page

3.09 Schedule - Equipment Colors

Equipment	Color
Blowers	*
Compressors	*
Couplings	Yellow
Cranes (Hoists)	Yellow
Blocks	Yellow and Capacity in Black
Fans	Orange
Flow Meters	*
Gear Reducers	Yellow
Guards	Orange
Motors	Orange
Pumps	*
Screens	*
Switch Enclosure	Orange
Tanks	*
Valves	*
Valve Operators	Yellow
Handrail/Guardrail	Orange **
Handrail/Guardrail-Removable	Yellow & Black **
Fire Protection Equipment	Red
Emergency Stop Bars, Buttons, Etc.	Red
First Aid Kits and Enclosures- containing First Aid Equipment	Green
Safety Showers, Face Washes, etc. (Area Around)	Green
Transformers	Orange
Switchgear	Grey or Buff
Misc. Metal	Black (unless otherwise noted)
* Color will depend on service. The color will be obtained from the "PIPE COLOR CODE" for the service. (No stripes used on equipment.) ** 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 Z535.1-2006.

3.10 Schedule - Piping Colors

Service	Color	Stripe
Potable Water - Cold	Green	
Potable Water - Hot	Green	Aluminum (1)
Emergency Shower Water	Green	Yellow (1)
Flushing Water	Gray	Blue (1)
Decant Water	Gray	White (1)
Industrial Water	Blue	
Ground Water	Blue	Green (1)
Instrument Air	Purple	Blue (1)
Natural Gas	Yellow	
Vacuum	Purple	Aluminum (1)
Roof Conductors	Match Background	
Floor Drains	Match Background	
Sump Pump Discharge	Gray	Black (1)
Sanitary Drains & Vents	Black	
Raw Sewage or Wastewater	Gray	
Sample Lines	Match System Being Sampled	
Electrical Conduit	Match Background	
Stainless Steel		6" band with $\frac{3}{4}$ " stripes at 1"
Copper		6" band with $\frac{3}{4}$ " stripes at 1"
Plastic		6" band with $\frac{3}{4}$ " stripes at 1"

Daily Coating Inspection Report Form on Next Page

Paint Inspection: Daily Coating Inspection Report

Project/Client:		Date: / / M T W Th F S Su		Pg. Of	
Location:		Project #:		COPY To:	
Description:		Inspector:		<input type="checkbox"/> QC Mgr <input type="checkbox"/> Owner <input type="checkbox"/> Contr <input type="checkbox"/> _____	
Requirements:				Attachments:	
Contractor:		Spec #		<input type="checkbox"/> DFT Sheet <input type="checkbox"/> NCR/CAR <input type="checkbox"/> _____	
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 _____ <input type="checkbox"/> Steel <input type="checkbox"/> Galvanize <input type="checkbox"/> Concrete <input type="checkbox"/> Other _____ <input type="checkbox"/> Hazard _____ <input type="checkbox"/> Sample Report # _____ <input type="checkbox"/> Degree of contamination: _____ Test: <input type="checkbox"/> Cl _____ $\mu\text{g}/\text{cm}^2$ / ppm <input type="checkbox"/> Fe _____ ppm <input type="checkbox"/> pH _____ <input type="checkbox"/> Degree of Corrosion: _____ <input type="checkbox"/> Scale <input type="checkbox"/> Pitting/Holes <input type="checkbox"/> Crevices <input type="checkbox"/> Sharp Edges <input type="checkbox"/> Weld _____ <input type="checkbox"/> Moisture <input type="checkbox"/> Oils <input type="checkbox"/> Other _____ <input type="checkbox"/> Painted Surface Condition: _____ Dry to: <input type="checkbox"/> Touch <input type="checkbox"/> Handle <input type="checkbox"/> Recoat <input type="checkbox"/> Dry/Over Spray <input type="checkbox"/> Runs/Sags <input type="checkbox"/> Pinholes <input type="checkbox"/> Holidays <input type="checkbox"/> Abrasion <input type="checkbox"/> Fall Out <input type="checkbox"/> Other _____		Time (Indicate AM or PM) : : : : Dry Bulb Temp ⁰ (C/F) : : : : Wet Bulb Temp ⁰ (C/F) : : : : % Relative Humidity : % : % : % : % Surface Temp ⁰ (C/F) Min/Max : / : / : / : / Dew Point Temp ⁰ (C/F) : : : : Wind Direction/Speed : : : : Weather Conditions: : : : :			
Surface Preparation		Application			
Start Time: _____ Finish Time: _____ Est Sq/ft: _____ <input type="checkbox"/> Solvent Clean <input type="checkbox"/> Hand Tool <input type="checkbox"/> Power Tool <input type="checkbox"/> HP Wash PSI _____ <input type="checkbox"/> Other _____ <input type="checkbox"/> Abrasive Blast <input type="checkbox"/> Abrasive Type _____ <input type="checkbox"/> Sample <input type="checkbox"/> Blast Hose Size _____ <input type="checkbox"/> Nozzle Size / PSI _____ <input type="checkbox"/> Air Supply CFM _____ <input type="checkbox"/> Air Supply Cleanliness <input type="checkbox"/> Water/Oil Trap Check <input type="checkbox"/> Equipment Condition Check		Start Time : _____ Finish Time : _____ Est. Sq/ft. _____ <input type="checkbox"/> Primer <input type="checkbox"/> Intermediate <input type="checkbox"/> Topcoat <input type="checkbox"/> Touch-up Generic Type: _____ Qty Mixed: _____ Manuf.: _____ Mix Ratio: _____ Prod Name: _____ Mix Method: _____ Prod #: _____ Strain/Screen: _____ Color: _____ Material Temp: _____ ⁰ F Kit Sz/Cond.: _____ Sweat-in Time: _____ Min/Hrs Shelf Life: _____ Pot Life: _____ Min/Hrs			
Surface Cleanliness & Profile Measurement		Batch #'s			
<input type="checkbox"/> Job Specification <input type="checkbox"/> SSPC/NACE - SP- _____ <input type="checkbox"/> SSPC/NACE Spec / Visual Stds <input type="checkbox"/> _____ Profile Check: _____ <input type="checkbox"/> Disc <input type="checkbox"/> Tape <input type="checkbox"/> Gauge <input type="checkbox"/> Specified _____ mils avg. / Achieved _____ mils <input type="checkbox"/> Surface effect on DFT Gauge/BMR _____ mils		Reducer #: _____ Qty Added: _____ Pt/Qtz/Gal % by Vol: _____ % Specified WFT Avg: _____ Mils Achieved WFT Avg: _____ Mils <input type="checkbox"/> Airless/Conv. Spray <input type="checkbox"/> Brush <input type="checkbox"/> Roller <input type="checkbox"/> Other _____			
Dry Film Thickness					
Gage Type / Model	Gage Serial #	Gage Calib. Verified	Spec Avg. DFT	Total Avg DFT	DFT Last Coat
Inspector's Signature					Date

End of Section

Division 10
Specialties

Section 10 1400 Signs

Part 1 General

1.01 Section Includes

- A. Metal, painted safety signage.
- B. Cast aluminum dedication plaque.
- C. Miscellaneous mounting hardware and anchors.

1.02 Submittals

- A. Shop Drawings:
 - 1. Submit shop drawings under provisions of Section 01 3300.
 - 2. Submit shop drawings listing sign styles, lettering and locations, and overall dimensions of each sign.
 - 3. Submit full size drawing of plaque indicating actual text size, spacing, and width.
- B. Samples:
 - 1. Submit samples under provisions of Section 01 3300.
 - 2. Submit two (2) samples illustrating full size sample sign, of type, style and color specified including method of attachment.
- C. Instructions:
 - 1. Submit manufacturer's installation instructions under provisions of Section 01300.
 - 2. Include installation template and hardware.

1.03 Delivery, Storage and Handling

- A. Deliver products to site under provisions of Section 01 6000.
- B. Store and protect products under provisions of Section 01 6000.
- C. Package signs, labeled in name groups.
- D. Store adhesive tape at ambient room temperatures.

1.04 Environmental Requirements

- A. Do not install adhesive tape mounted signs when ambient temperature is below 70 degrees Fahrenheit (21 degrees Celsius). Maintain this minimum during and after installation of signs for adhesive to cure.

Part 2 Products

2.01 Manufacturers

- A. Safety Signage:
 - 1. Stonehouse
 - 2. Seton Name Plate Company
 - 3. Brady, USA, Inc.

- B. Dedication Plaque:
 - 1. The Supersine Company
- C. Substitutions: Under provisions of Section 01 2513.

2.02 Lettering

- A. Dedication Plaque:
 - 1. 1-inch Helvetica Medium lettering (400 letters, maximum); upper- and lower-case lettering as selected by OWNER.
- B. Safety Signage:
 - 1. Per MIOSHA requirements.
 - 2. Colors: As noted in Signage Schedule.

2.03 Accessories

- A. Dedication Plaque: Tamper-resistant, corrosion proof wood screws, material and finish to match plaque.
- B. Safety Signage: Non-corrosive, stainless steel, theft-proof mounting screws and anchors for required for substrate.

Part 3 Execution

3.01 Examination

- A. Provide signage for each of the rooms or areas identified in the Signage Schedule.
- B. Provide safety signage as indicated in the Signage Schedule.
- C. Verify that surfaces are ready to receive work.
- D. Beginning of installation means installer accepts existing surfaces.

3.02 Installation

- A. Install in accordance with manufacturer's instructions and current State of Michigan Barrier Free requirements.
- B. Install signs after surfaces are finished, in locations adjacent to the doors (or adjacent to accessories for safety signage), at the required heights to meet current State of Michigan Barrier Free, and applicable NFPA, MIOSHA requirements.
- C. Use fasteners appropriate for the substrate.
- D. Locate sign on wall surface, level.
- E. Clean and polish.

3.03 Signage Schedule

- A. Unsafe Water Sign:
 - 1. CONTRACTOR shall furnish and install a sign reading "CAUTION Unsafe Water Do Not Drink" at all industrial water outlet locations.
 - 2. Sign shall be a minimum of 10-inches wide and 8-inch high with letters a minimum 1-inch high.

3. Sign shall be of weatherproof construction, permanently affixed to the building structure.
4. The word "CAUTION" shall be yellow on a black background in the upper panel. The lower panel where additional wording is, shall be black letters on a yellow background.

B. Dedication Plaque:

1. Dedication Plaque: 18-inch by 24-inch, cast aluminum No. 214 alloy, standard radius border edge No. 505 with pebble background, plaque finish No. AL-100: letters to be satin polish finish. Spray entire plaque with 2 coats of clear lacquer upon completion.
2. Plaque copy to be determined by OWNER based on 400 letters total; minimum of one hundred 1-inch letters, one hundred 3/4-inch letters, one hundred fifty 5/8-inch letters and fifty 3/8-inch letters, made up of both upper- and lower-case Helvetica Medium letters.

End of Section

Division 11
Equipment

Section 11 0500 Common Work Results for Equipment

Part 1 General

1.01 General Requirements

- A. The Contract Drawings and the general provisions of the specifications included in Division 0-Contract Provisions and Division 1-General Requirements, are a part of these Specifications. CONTRACTOR shall consult them for instructions pertaining to the work.
- B. 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. CONTRACTOR shall refer to the drawings to ascertain which systems he is 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 Section(s) and shall apply.

1.02 Work Included

- A. These specifications and the accompanying Contract Drawings are intended to comprise the furnishing and installing of all materials, equipment and supplies as specified herein and required for the satisfactory completion by CONTRACTOR of all work including the installation of OWNER-furnished equipment, if specified.
- B. The Drawings and these specifications are complementary to each other in that all apparatus, materials and equipment shown on the Drawings and/or specified herein shall be considered essential to the requirements of the Contract.
- C. 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 apparatus and equipment furnished and installed by 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.

1.03 Shop Drawings and Operation & Maintenance Manuals

- A. Shop drawings are required for each item of equipment, apparatus, device and piping furnished. Shop drawings shall be submitted as described in Section 01 3300.

Part 2 Products (Not Used)

Part 3 Execution

3.01 Drawings and Measurements

- A. The Drawings show the arrangement, general design and extent of the systems. 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. 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 CONTRACTOR.
- C. Field measurements necessary for getting out materials and fitting in the installation to the building construction shall be taken by CONTRACTOR.

3.02 Record Drawings

- A. CONTRACTOR shall comply with all requirements of Section 01 7700.

3.03 Cutting and Repairing

- A. All cutting and repairing of existing and completed work, including manholes, which is required for the installation of CONTRACTOR's work shall be done by the respective contractors for the various trades involved, at CONTRACTOR's expense.
- B. CONTRACTOR shall provide openings in the floors, walls, etc., as required for the installation of the piping and equipment.

3.04 Apportionment of the Work

- A. CONTRACTOR shall classify and apportion all materials and the performance of all labor to the several trades involved in accordance with all local customs, rules, regulations, jurisdictional awards, decisions, etc., insofar as they may apply to and as required to efficiently execute the work involved in this Contract, regardless of the classification indicated in these specifications.

3.05 Materials and Equipment

- A. All material shall be new and be the standard products of the manufacturer, unless otherwise specified or approved by OWNER. OWNER reserves the right to disapprove and reject any materials, proposed or installed, which in his opinion fail to meet these quality standards. CONTRACTOR shall, at his own expense, remove and replace with approved materials, any materials which in the opinion of OWNER do not comply with these quality standards.
- B. When a specific manufacturer or trade name is mentioned in these specifications, and/or on the drawings, it is used to establish a standard of quality. Substitution of other makes of equal quality may be made, subject to the approval of OWNER, in accordance with the General Conditions.
- C. Any substitutions so made, shall be deemed to be made for the convenience of CONTRACTOR and any and all additional costs resulting therefrom shall be borne by CONTRACTOR making the substitution.
- D. Any items required to complete the work and not specifically mentioned herein, shall conform fully to the quality pattern established by these specifications.

3.06 Storage and Handling of Materials and Equipment

- A. CONTRACTOR shall coordinate delivery of equipment with his construction program so that an undue amount of storage space is not required. Space for contractor's use will be designated by OWNER.

- B. CONTRACTOR shall exercise care in the protection of materials and equipment furnished and/or installed under this contract while they are in storage at the site and during and after installation prior to final acceptance.
- C. All materials and equipment shall be handled in a manner to avoid damage or breakage and delay in the completion of the work. CONTRACTOR shall repair or replace, without cost to OWNER and to the satisfaction of OWNER, all items damaged or broken as a result of his operation.
- D. All machined surfaces of the equipment subject to corrosion shall be protected by coating with grease immediately after finishing.
- E. All flanges shall be protected prior to installation by means of wooden flanges bolted in place.
- F. Pump casings shall be thoroughly drained of all water.
- G. Equipment and materials stored outdoors shall be blocked up at least six inches above the ground.
- H. Openings in tanks, valves and pipe shall be kept covered to prevent dirt, rubbish or water from entering, with machined surfaces such as flange faces, pipe threads, machined weld ends of pipe, and fittings protected from corrosion by proper Owner approved compounds.
- I. All materials shall be protected from serious shock, denting, and marring of surfaces.
- J. All unpainted steel surfaces shall be prevented from rusting by an Owner approved method.
- K. Plate and sheet metal work shall be handled and stored with care to prevent permanent deformations or crimps in the material.
- L. Whenever the shop coat of protective paint is damaged, spot coating shall be made immediately to prevent rusting.
- M. All parts of the equipment shall be carefully crated to facilitate shipping and handling. The crates shall be constructed to completely protect the equipment and shall be sufficiently strong to permit lifting and skidding without requiring additional bracing or reinforcement.
- N. All materials shall be so delivered, stored, and handled as to prevent the inclusion of foreign materials and/or damage by water, breakage or other causes. Packaged materials shall be delivered in original unopened containers and shall be stored until ready for use. Packages or materials showing evidence of damage or contamination, regardless of cause, will be rejected. All materials which have been stored shall be subject to retest and shall meet the requirements of these Specifications at the time they are used in the work and at the time of final acceptance of the work.
- O. CONTRACTOR shall obtain a letter from the equipment manufacturer describing the recommended methods of outdoor or indoor storage of the equipment at the site and shall fully comply with such recommendations.

- P. All materials to be incorporated in the work shall be properly arranged, covered, and protected and CONTRACTOR shall be solely responsible for the safety of the same.
- Q. Materials may be stored on the site in locations designated by OWNER.

3.07 Asbestos

- A. No asbestos containing materials shall be allowed on the job site. No asbestos gaskets, packing insulation, etc. shall be furnished as a part of any item provided under these specifications.

3.08 Maintenance Prior to Final Acceptance

- A. CONTRACTOR shall be responsible for the maintenance of equipment and systems installed until final acceptance by OWNER and shall take such measures as necessary to ensure adequate protection of all equipment and materials during delivery, storage, installation, start up, temporary operation, and shut down.

3.09 Adjustment and Operation of Systems

- A. When the work included in these specifications is complete, and at such time as directed by OWNER, CONTRACTOR shall adjust all parts of the systems, advising OWNER when this has been done and the work is ready for final tests.
- B. If it becomes necessary for temporary use of the systems by CONTRACTOR, before all parts are complete, CONTRACTOR shall adjust all parts as far as possible in order to make said temporary use as effective as possible.
- C. If such temporary use is for OWNER's benefit and cleaning or repairing of damage is necessary due to OWNER's actions, such cleaning and repair cost shall be paid by OWNER based on a prior negotiated price.
- D. 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.

3.10 Equipment Bases

- A. All equipment on concrete floors shall be mounted on minimum 6" high concrete pads, unless otherwise noted on the drawings or required by the equipment for proper installation.
- B. All motor driven equipment installed by suspension from building structure shall be so designed and so installed as to effectively isolate all vibration of the equipment from the building structure. OWNER will reject any installations where equipment vibration is not effectively isolated.
- C. Except where otherwise hereinafter specified, CONTRACTOR shall provide structural steel or cast-iron bases for all equipment which is to be installed on concrete floor slabs. Unless otherwise shown on the drawings, motors and the equipment they drive, shall be mounted on common bases from the floor.

- D. Where structural bases, integral with floor slabs, are required, these shall be the responsibility of CONTRACTOR. These shall be sized as recommended by the manufacturer of the equipment. CONTRACTOR shall arrange for their pouring at the same time as the floor slab. All costs incidental to the pouring of these bases shall be the responsibility of CONTRACTOR including modification of the details as shown on the drawings.

3.11 Nameplates

- A. Each component of equipment, unless otherwise specified, shall have the manufacturer's name and catalog number on a plate securely attached to the item or equipment, or the name and catalog number may be stamped or cast into the body of the item, nameplates shall also give data pertinent to the operation and characteristics of the equipment.
- B. All equipment installed shall be identified in accordance with the following unless otherwise indicated on the drawings.
- C. Individual pieces of equipment shall bear legend plates identifying the equipment numbers as called for on the drawings. Plates shall be white laminated plastic with engraved black letters.
- D. The legend plates shall be 1-1/4" high and 3-1/2" wide and shall be attached to the equipment by means of stainless-steel countersunk head machine screws with Phillips slots. The plates shall be approximately 3/32-inch-thick with beveled edges and shall have letter sizes and legends as approved by OWNER.

3.12 Coordination

- A. Before proceeding with installation of piping, ductwork or other system, contractor shall inspect the contract documents and determine that the location of the work does not interfere with other work. In case of interference, OWNER shall be notified in writing. OWNER shall then determine the resolution of the interference and shall so inform CONTRACTOR. OWNER's decision shall be binding.

3.13 Acceptance Tests

- A. Upon completion of each installation of each equipment or process system and within 60 days after the date of initial operation of each system, CONTRACTOR shall, at his expense, conduct complete performance tests in the presence of OWNER, to fully demonstrate the capacity and all other characteristics of each system. These tests shall be run for not less than one (1) hour for each point and shall fully demonstrate the ability of each piece of apparatus to perform as herein required and/or as called for on drawings and/or shown on the catalog of the manufacturer of the specified item and/or shown on the submitted shop drawings.
- B. Upon completion of the work, CONTRACTOR shall conduct a complete inspection of all items of work required by the contract documents, and make whatever corrections and adjustments are necessary to obtain a complete, well functioning system, which meets the requirements of OWNER. All nameplates on equipment shall be kept clean for easy reading.

- C. Pumps, motors and apparatus shall be made to operate at any condition up to full capacity without undue vibration, objectionable noise or overheating. Motors shall be proven not to heat to a temperature exceeding 80 degrees centigrade.
- D. CONTRACTOR shall provide all materials and labor necessary to perform these tests.
- E. This Specification shall apply unless more stringent tests are outlined for a particular item of equipment.

3.14 Pressure Tests

- A. The testing requirements for the respective piping systems shall include all those of the applicable governing codes, such as state, local, and insurance, and those hereinafter specified. All code required inspection certificates shall be furnished by CONTRACTOR, as required.
- B. CONTRACTOR shall make pressure tests on all piping included in the contract. All tests shall be made before piping is painted, covered or concealed. CONTRACTOR shall furnish all pumps, compressors, gauges and other necessary testing equipment, material, and labor, and make all connections necessary for the tests.
- C. The FEW system piping shall be tested at 100 psi for a period of one hour.
- D. The Wastewater piping shall be tested at 50 psi for a period of one hour.
- E. All tests shall be made in the presence of OWNER and where required, the inspection department having jurisdiction, who shall be notified by CONTRACTOR in sufficient time to enable him to be present. If inspection or tests show defects, such defective work or material shall be replaced, and inspection and tests repeated. All repair to piping shall be made with new material and to the satisfaction of the authorized inspectors.

3.15 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 CONTRACTOR and stored at a location on the site as designated by OWNER.

3.16 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.

3.17 Alignment

- A. Alignment of all mechanical equipment shall be field checked by CONTRACTOR and adjusted as required prior to equipment start-up. This includes drives, couplings and piping connections. Log sheets for each coupling shall be submitted and shall include: date of alignment, gap, end float, angular and offset measurements. Log sheets shall also include the coupling manufacturer's maximum allowable for each measurement. The measured misalignment shall not be greater than 50% of the maximum allowable.

- B. Piping connection to all mechanical equipment shall be disconnected after the installation is complete to verify that no strain is being placed on the equipment by the piping.

3.18 Vibration

- A. Equipment shall be designed and installed so as to preclude excessive vibration. OWNER will reject any installations where excessive equipment vibration is in evidence.

3.19 Inserts and Anchor Bolts

- A. The pumps are to be secured to the concrete basin floors with expansion type stainless steel anchor bolts.
- B. For the suspended piping, anchor bolts shall be Red-Head, Hilti, Wejit, Parabolt, Kwikbolt, or equal. The by-pass discharge piping shall be supported from the overhead pre-cast decking with stainless steel bolts specifically recommended by the manufacturer for drilling into pre-cast decking.

End of Section

Division 22
Plumbing

Section 22 1329.16

Dry Pit Submersible Sewerage Pumps

Part 1 General

1.01 General Requirements

- A. Provide two dry pit submersible pumps as shown on the drawings with control panel and accessories as specified herein.

1.02 Items Specified Elsewhere

- A. Equipment bases shall be as specified in Section 11 0500 of these Specifications and as detailed in the Contract Drawings.

1.03 Electrical Requirements

- A. The requirements of all applicable Sections of Division 26, Electrical, and all other applicable Sections of these Specifications, form a part of this Section and govern work covered in this Section.

1.04 Submittals

- A. Shop drawings shall be submitted in accordance with Section 01 3300, Submittal Procedures.
- B. Operation and maintenance manuals shall be submitted in accordance with Section 01 6000, Product Requirements and Section 01 7700, Closeout Procedures.

1.05 Warranty

- A. The pumping system, consisting of submersible wastewater pumps and intelligent control panel, shall be provided with a 7-year (84 months) warranty against defects in materials and or workmanship. The warranty shall be in printed form, included with the product submittal, and previously published as the manufacturer's standard warranty for all similar units manufactured. Upon warranty occurrence, the manufacturer's authorized service center shall repair the pump. A detailed failure analysis shall be submitted to OWNER for their records summarizing corrective action taken.
- B. The manufacturer shall guarantee clog-free operation for a period of 24 months from the date of start-up of the pumps by the local authorized factory representative. A certificate shall be provided to OWNER on the day of start up with the local contact information and effective date. Should the impeller clog with typical solids and/or modern trash debris normally found in domestic wastewater during this period, an authorized representative shall, either travel to the jobsite, remove the pump, clear the obstruction and reinstall the pump at no cost or reimburse OWNER for reasonable cost to provide this service. A written report shall be provided to OWNER detailing the service call with pictures for verification purposes.

Part 2 Products

2.01 Work Included

- A. This section covers the supply and installation of pumping equipment.

- B. CONTRACTOR shall furnish and install all necessary supports, framing, motors, cable supports and all other appurtenances specified herein or required for a complete installation.
- C. CONTRACTOR shall provide certified copies of head capacity curves for all pumps based on test data from similar pumps. Curves shall also include pump efficiency and horsepower. The motor horsepower specified or shown on the drawings shall be considered the maximum acceptable horsepower for the pump.
- D. Alignment of all pumps shall be field checked and adjusted as required prior to startup of pumps.

2.02 Manufacturer

- A. Furnish and install three (3) dry pit submersible non-clog wastewater pumps for a grit slurry pumping application.
- B. Each pump shall be equipped with a 7.5 HP submersible electric motor connected for operation on 460 volts, 3 phase, 60 hertz with 50-ft of motor and sensor cable. The power cable shall be sized according to NEC and ICEA standards and have P-MSHA Approval.
- C. The pumps shall be rated for 240 gpm at 50-ft TDH.
- D. The pumps shall be submersible sewage pump with integrated control system for horizontal dry installation (Flygt NZ 6020/Concertor),

2.03 Pump Requirements

- A. Pump Configuration:
 - 1. Pump shall be capable of operating in a continuous non submerged condition in horizontal position in a dry pit installation, permanently connected to inlet and outlet pipes. Pump shall be of submersible construction and will continue to operate satisfactorily should the dry pit be subjected to flooding.
 - 2. Pump shall have a stainless steel telescoping inlet pipe for ease of inspection. Pressure gauge connection shall be included standard on telescoping inlet pipe. The volute shall have a conveniently located drain tube to aid with inspection and or maintenance operations. Optional Service Cart shall be provided for safety and maintenance purposes.
- B. Pump Construction:
 - 1. It shall be permanently submersible according the protection class IP 68. It shall continue to operate satisfactorily even when the station is subjected to a flooding and the motor is permanently submerged by a water column of 65 feet. Motors which only can be submerged for a limited time (IP 67) shall not be considered as equal.
 - 2. The motor shall capable to operate the pump at continuous duty (S1) in an ambient temperature up to 104 degrees Fahrenheit. Operational restrictions or the demand of auxiliary cooling systems like fans or blowers are not acceptable.
 - 3. The pump shall be operated by a synchronous motor and an integrated control system and be capable to run at constant power at any point of the performance

field without being overloaded. Motor shall utilize a permanent magnet rotor to maintain synchronous speed.

4. The motor shall withstand at least 60 starts per hour.
5. The discharge/suction flange of the pump shall be as shown on the drawings. Both shall be drilled according ANSI.
6. The volute shall have conveniently located drain to aid with inspection and or maintenance operations.
7. The impeller shall be mounted on the motor shaft. Couplings shall not be accepted.
8. Due to the likely presence of sand and or grit the impeller and the insert ring shall be made of ASTM A-532 Alloy III A with 25% chrome and the leading edges shall be hardened to 60 HRC.
9. An integrated pump control system installed in the pump/motor housing shall start the pump by gradually increasing the pump speed. The starting current shall not be higher than the rated current.
10. An integrated pump control system installed in the pump/motor housing shall secure that the direction of the impeller rotation is always correct. There shall be no need for any human intervention to ensure that the impeller is rotating in the correct direction within the volute. The integrated control system shall be inside the motor and encapsulated to protect it against moisture ingress, and vibration.
11. The motor and the pump control system shall receive sufficient cooling from the pumped liquid to operate the pump at continuous duty in a liquid with a temperature with 104 degrees Fahrenheit. Operational restrictions on the liquid temperature below 104 degrees Fahrenheit or the demand of auxiliary cooling systems like fans or blowers are not acceptable. The Stator shall be inverter duty rated in accordance with NEMA MG1, Part 31 and be insulated according class H (356 degrees Fahrenheit).
12. Motor, pump and control system shall be designed and supplied by the pump manufacturer.
13. The control system shall continuously monitor the leakage sensor in the stator housing and the temperature of the motor. It shall be impossible to overload the motor. If the motor temperature is too high, the pump shall continue to operate at reduced power until conditions are normalized. External trips or overload devices for motor protection shall not be required.
14. The operator shall be able to modify the setting of the control system to decide if the active leakage signal shall stop or not stop the pump.
15. The pump shall incorporate a "pump-cleaning" function to remove debris from the impeller. The cleaning function shall be initiated when the integral control system senses an increase in current draw due to debris in the pump. The cleaning function shall consist of forced stopping, reversal and forward runs timed to allow for debris to fall from the impeller.
 - a. After cleaning cycle is complete, the pump shall resume to automatic operation.

- b. If the pump impeller/volute does not clear itself after the programmed number of attempts, the control shall initiate an alarm to notify that the pump inlet / volute is blocked by large debris.
- 16. It shall be possible to access and adjust the pump system with a Human Machine Interface (HMI) ranging from basic monochrome displays to full-color touch screen units and smartphone or tablet. It shall enable the operator to view and control entire pump system and logged operational data like number of starts, avoided clogging instances, pump run-time, motor power, motor current, power factor, temperature, pump leakage etc.
- 17. The shaft shall rotate on two bearings. The motor bearings shall be sealed and permanently grease lubricated with high temperature grease. The upper motor bearing shall be a single row ball bearing to handle radial loads. The lower bearing shall be a double row angular contact ball bearing to handle the thrust and radial forces. Single row lower bearings are not acceptable. The minimum L10 bearing life shall be 50,000 hours at any usable portion of the pump performance field.
- 18. The shaft shall be sealed by a tandem mechanical shaft seal system consisting of two seals, each having an independent spring system. The seals shall require neither maintenance nor adjustment and shall be capable of operating in either clockwise or counterclockwise direction of rotation without damage or loss of seal function.
- 19. Where a seal cavity is present in the seal chamber, the area about the exterior of the lower mechanical seal in the cast iron housing shall have cast in an integral concentric spiral groove. This groove shall protect the seals by causing abrasive particulate entering the seal cavity to be forced out away from the seal due to centrifugal action.
- 20. The Materials of construction shall be as follows:
 - a. Pump housing: ASTM A-48, Class 35B
 - b. Impeller and insert ring: A 532 ALLOY III A (25% chrome)
 - c. Stator housing: GD-AL SI 12 or ASTM B85A 413
 - d. Shaft: ASTM A479 S43100-T.
 - e. Shaft seal: Pump side: - Corrosion resistant Tungsten carbide WCCR
 - f. Shaft seal Motor side: - Corrosion resistant Tungsten carbide WCCR
- 21. All castings must be blasted before coating. All wet surfaces are to be coated with two-pack oxyrane ester Duasolid 50. The total layer thickness should be at least 120 microns. Zink dust primer shall not be used.
- 22. The motor shall be equipped with 30 feet of screened cable S3x6+3x6/3+S(4x0,5) suitable for submersible pump applications. The power cable shall be sized according to NEC and ICEA standards. The outer jacket of the cable shall be oil resistant chlorinated polyethylene rubber. The cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet.
- 23. Each completed and assembled pump/motor unit shall undergo the following factory tests at the manufacturer's plant prior to shipment:
 - a. Hydraulic performance test
 - b. No-Leak seal integrity test.

2.04 Support Stand and Service Cart for Pump(S)

- A. Each Pump shall have an integral 316 stainless steel suction service inlet for ease of inspection and visual verification of impeller clearance using a feeler gage. The use of spool pieces, clamping type fittings, TEEs, or other devices which require removal of fittings, hoists, cranes and/or lifting devices, or that potentially impart negative hydraulic impact to the pump inlet per HI standards shall not be considered acceptable. All service inlet devices shall be hydrostatically tested and integrally mounted to the pump volute for the pump working pressure. Pumps that rely on externally adjusted wear plates risk non-uniform adjustment, bearing damage, and which do not facilitate visual impeller inspection will not be acceptable. The use of pipe expansion joints to facilitate impeller gap adjustment shall not be acceptable. A ¼" pressure gauge connection shall be included standard on the suction service inlet.
- B. The suction flange shall be as shown on the drawings and drilled according ANSI B16.1-89; tab.5.
- C. Each motor shall be assembled on a 316 stainless steel service cart with rollers and 2 rails. The cart shall provide a rigid support and enable the removal of the rotating assembly from volute without disturbing volute or piping and without the need for hoists or lifting apparatus during impeller maintenance. The service cart and the rails to pull out motor with the impeller to enable wear ring, impeller, and lower seal replacement without the need for hoists, cables, or pulley systems.
- D. It shall be possible to rotate the pump housing in steps of 45° to connect the discharge flange to the discharge pipe without the demand of additional elbows.

2.05 Pressure Gauges

- A. Pressure gauges shall be provided and installed on the suction and discharge lines of each pump. Range for the gauges shall be 0-50 psi on the discharge and 15-0-15 psi on the suction. Gauges shall be a minimum of 4 inches in diameter and shall be glycerin filled. Rated accuracy shall be one percent (1%) of full-scale readings. Gauges shall be Ashcroft or equal.
- B. Gauges shall be mounted firmly secured to pumps or piping. Gauge installations shall be complete with all hoses and fittings and shall include a shutoff valve and sludge/solids isolator installed in each gauge line at the point of connection to suction and discharge pipes. Isolator shall be Red Valve Series 742 or equal.

2.06 Submersible Cable Connection Box Acc. NEMA 6P

- A. The submersible cable of the pump shall be connected to the wall mounted Power & monitoring cables in a cable connection box to ease the installation and disassembling of the pumps.
- B. The cable connection box shall be submersible NEMA 6P (IP 67) to secure that no water can enter the motor via the cables even when the complete station is flooded
 - 1. Major pump components shall be of grey cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. The lifting handle shall be of stainless steel. All exposed nuts or bolts shall be AISI type 316 stainless steel construction. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

2. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or optional Viton rubber O-rings. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.
3. Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

2.07 Pumping System Gateway (Flygt FPG 414 DP)

- A. Each pump shall be equipped with 1 Pump gateway which shall offer at least following interfaces: 1 x USB, 1 x RS485 1 x Ethernet RJ 45 1 x Display interface, 4 x Digital outputs, 4 x Digital inputs, 1 x Analog input & output.
- B. It shall supply following pump data:
 1. Start and stop commands
 2. Power consumption information
 3. Operating speed
 4. Running status
 5. Fault information
- C. The housing shall be isolated according protection class IP 20 applicable to operate in ambient temperature: -20 °C to +60°C.
- D. It shall be applicable for 24 V DC Power supply.
- E. The Pump gateway shall allow to control of the pump through I/O or Modbus RTU or TCP.
- F. It shall have emergency run relay functionality which secures that the pump will operate when the main controller fails.
- G. The unit shall be tested and approved in accordance with international standards CE, UL, RCM and CSA and be designed and manufactured by the pump supplier

2.08 Intrinsically Safe Barriers

- A. Provide intrinsically safe barriers for all IO that enters the wet well.

2.09 UPS

- A. Provide a 24VDC power supply with battery backup capable of running all DC loads for a minimum of 1 hour.

2.10 Accessories

- A. Pressure gauges shall be provided and installed on the suction and discharge lines of each pump. Range for the gauges shall be 0-30 psi on the discharge and 15-0-15 psi on the suction. Gauges shall be a minimum of 4 inches in diameter and shall be glycerin filled. Rated accuracy shall be one (1%) percent of full-scale reading. Gauges shall be Ashcroft or equal.

- B. Gauges shall be mounted firmly secured to pumps or piping. Gauge installations shall be complete with all hoses and fittings and shall include a shutoff valve and sludge/solids isolater installed in each gauge line at the point of connection to suction and discharge pipes. Isolater shall be Red Valve Series 742 or equal

Part 3 Execution

3.01 Installation

- A. The pumps shall be installed in accordance with the instructions of the manufacturer and as shown on the Drawings.
- B. Field tests shall not be conducted until such time that the entire installation is complete and ready for testing.
- C. A certification from the equipment manufacturer stating that the installation of his equipment is satisfactory, that the equipment is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication and care of each unit shall be submitted.

3.02 Inspection Training Requirements

- A. A factory representative employed by the manufacturer shall visit the site prior to equipment start-up to verify the proper installation of the equipment.
- B. The factory representative shall return to the site during Start-up and Testing of the equipment to verify proper operation and to instruct OWNER's operating personnel in the maintenance and operation of these units. The scheduling of this service shall be coordinated with OWNER and the cost of this service shall be included in CONTRACTOR's bid price.
- C. Training requirements shall be a minimum 4 hours at the site, unless otherwise specified.

End of Section

Division 23
Heating, Ventilating, and Air-Conditioning

Section 23 0500

Common Work Results for HVAC

Part 1 General

1.01 Scope of Work

- A. This Section includes general provisions for all mechanical Work, inclusive of whatever miscellaneous material and/or equipment shall be required for successful operation of the mechanical systems as indicated on the Plans. This Section also includes requirements of electrical equipment, such as motor starters, controls, and instruments when furnished as components of the mechanical equipment or system.

1.02 Related Work Specified Elsewhere

- A. Section 03 3000: Cast-In-Place Concrete
- B. Section 09 9100: Painting
- C. Section 26 0500: Common Work Results for Electrical

1.03 Reference Standards

- A. These standard specifications have been prepared by authorities which are recognized by the mechanical trades. The names of these authorities are listed below together with the abbreviations of their names as they appear in the following Specifications:
 - 1. ASA - American Standards Association
 - 2. ASTM - American Society for Testing Materials
 - 3. AMCA - Air Moving and Conditioning Association
 - 4. AFBMA - Antifriction Bearing Manufacturing Association
 - 5. ASHRAE- American Society of Heating, Refrigerating & Air Conditioning Engineers
 - 6. ASME - American Society of Mechanical Engineers
 - 7. NEMA - National Electrical Manufacturers' Association
 - 8. AWWA - American Water Work Association
 - 9. UL - Underwriters Laboratories, Inc.
 - 10. FM - Factory Mutual
 - 11. NFPA - National Fire Protection Association
 - 12. ANSI - American Standards Association

1.04 Quality Assurance

- A. Workmanship:
 - 1. Work shall be performed in accordance with latest accepted standards and practices for the trades involved. The workmanship shall be subject to the approval of ENGINEER.
 - 2. Only craftsmen experienced in the Work to be performed will be allowed to do the Work. This applies particularly to skilled trades such as welding, pipe fitting, plumbing, and sheet metal work.
- B. Codes, Ordinances, Permits, and Inspections:
 - 1. Materials and equipment required for the Work and their installation shall conform to the laws of the state of Michigan and to codes, rules, regulations, and ordinances of the locality where the Work is to be performed.

2. CONTRACTOR shall secure all permits, licenses, inspections and tests required in connection with his Work.
3. Upon completion of the Work, CONTRACTOR shall secure and present to OWNER a certificate of inspection and approval from the department having jurisdiction over his Work, if such be issued. Fees in connection with the above requirements shall be paid by CONTRACTOR.
4. Changes in the drawings and/or Specifications required to conform to the above codes, laws, rules and/or regulations shall be taken up with ENGINEERS' office by CONTRACTOR before submitting his proposal.
5. After entering into the Contract, CONTRACTOR shall be held to make all changes required to conform to the above ordinances, laws, rules, and/or regulations without extra expense to OWNER, except in the instance of ordinances, laws, rules, and/or regulations which are revised or enacted subsequent to the time of signing the Contract.

C. Design Drawings:

1. General arrangements, design, and extent of the mechanical Work prescribed in these Specifications are indicated and/or detailed on the accompanying drawings. Any discrepancies which may occur on the drawings and/or in the Specifications shall be called to the attention of ENGINEER. No changes or alterations in the Work shall be made because of said discrepancies until approval of such changes or alterations has been secured from ENGINEER.
2. In the event of disputes arising because of discrepancies between drawings of the Architectural, Mechanical, and/or Electrical Trades, such disputes shall be taken up with ENGINEER whose decisions will be final.
3. Dimensions which tie mechanical and/or electrical installations to the building structure shall be thoroughly field checked for accuracy and possibility of interferences due to field conditions. Ignorance of such field conditions because of CONTRACTOR's failure to field check the dimensions in question will be no excuse for additional compensation.

D. CONTRACTORS' Interface:

1. CONTRACTOR shall be responsible to coordinate the furnishing and installation of all materials and labor required for a complete and operable facility.
2. CONTRACTOR shall be responsible to include adequate appurtenances to complete installation of equipment furnished by him when furnished as an integral part of a packaged piece of equipment or integral mechanical equipment system.
3. CONTRACTOR shall be responsible for furnishing and installing the necessary piping to provide a complete and operable installation of all equipment and fixtures whether or not said equipment and fixtures are furnished by CONTRACTOR.

E. Apportionment of the Work:

1. CONTRACTOR shall classify and apportion all materials and performance of labor to the several trades involved in accordance with all local customs, rules, regulations, jurisdictional awards, decisions, etc., insofar as they may apply and as required to efficiently execute the Work involved in this Contract regardless of the classification indicated in these Specifications.

F. Surveys:

1. CONTRACTOR shall layout and establish lines and grades of pipes in accordance with the drawings, and he shall employ a competent surveyor registered in the state of Michigan for this Work. In the event of unforeseen obstructions, CONTRACTOR shall confer with ENGINEER and obtain his written approval before proceeding with any Work deviating from the governing drawings. CONTRACTOR shall assume full responsibility for locations and grades throughout the Work.

G. Locations:

1. Process equipment, plumbing fixtures, and mechanical equipment shall be in the exact locations as determined by ENGINEER. It shall be the duty of CONTRACTOR to request such exact locations from ENGINEER sufficiently in advance of the time when such information will be required at the buildings so as not to interfere with progress of his Work.

H. Points of Termination:

1. The points of connection and termination of the Work under these sections of the Specifications are shown on the drawings or stated in the Specifications, but in case of doubt as to such points of connection or termination, the decision of ENGINEER shall be final.

I. Local Utilities:

1. CONTRACTOR shall be responsible for coordinating, obtaining service, including costs and advising ENGINEER and utility company(s) as to installation schedules.

1.05 Submittals

A. Shop Drawings and Manufacturer's Data:

1. Submit shop drawings and/or manufacturer's data as required in Section 01300, Submittals. Shop drawings used during construction as temporary record documents shall comply as specified within these Contract Documents.

B. Operation and Maintenance Data:

1. CONTRACTOR shall submit operating instructions, repair parts lists, equipment manuals, and automatic control diagrams. Submittals shall be as required in Section 01300, Submittals. In addition, one copy of each automatic temperature control diagram shall be framed and glazed, and wall mounted in an area designated by OWNER, showing all temperature controls relating to equipment.
2. CONTRACTOR shall also provide ENGINEER with additional copies of the above material, each copy to be bound in book or pamphlet form with approved

fastenings and covers. Each bound copy shall include a set of the final and approved shop drawings of all equipment, fixtures, and accessories used on this Project.

C. Record Drawings:

1. Submit record drawings as required in Section 01 7700, Closeout Procedures. Drawings shall clearly marked by CONTRACTOR with accurate field dimensions locating mechanical systems, equipment, piping, component parts, etc.

1.06 Product Delivery, Storage, and Handling

A. Storage:

1. Erect and maintain a weatherproof storage shed or weatherproof storage trailer on the premises, as necessary, of sufficient size to adequately receive and house the miscellaneous equipment and materials subject to damage by exposure to the weather.
2. Storage facility shall be located after consultation with ENGINEER and OWNER. OWNER reserves the right to deny CONTRACTOR the privileges of storing material onsite.

1.07 Job Conditions

A. Protection:

1. Pipe ends, and parts of equipment left unconnected shall be capped, plugged or properly covered to prevent the intrusion of foreign matter.
2. The use of tarpaulins or plastic sheets for temporary enclosures, protection of materials, etc., will not be permitted in areas where burning and/or welding operations are going on or in any location where there may be the slightest hazard of their use contributing to a fire.

B. Sequencing:

1. CONTRACTOR shall be responsible for sequencing the Work of Subcontractors to avoid interferences and delays. Additional costs incurred as a result of changes in the Work to avoid interferences or delays shall be at the expense of CONTRACTOR.

C. Cutting and Patching:

1. Minor cutting that may be necessary for the installation of the Work and minor patching as a consequence thereof shall be done by CONTRACTOR after review by ENGINEER.
2. Major cutting of the structure necessary for the installation of the mechanical Work and major repairs required as consequence thereof shall be done by CONTRACTOR, after review by ENGINEER.

Part 2 Products

2.01 Materials

- A. When specific manufacturers or trade names are mentioned in these Specifications, and/or on the drawings, they are used as the design criteria and to establish a minimum of quality standard.
- B. Any substitution made that may affect building size or process function shall be deemed to be made for the convenience of CONTRACTOR, and all shall be brought to the attention of ENGINEER at an early date for consideration. Additional costs resulting therefrom shall be borne by CONTRACTOR.
- C. CONTRACTOR shall accept full responsibility that said substitution shall function as required by the process and shall not require additional building space or additional structural requirements. CONTRACTOR shall also be responsible for all redesign expenses incurred because of the substitution.
- D. Items required to complete the Work and not specifically mentioned herein, shall conform fully to the quality pattern established by these Specifications.
- E. Materials shall be new and be the standard products of the manufacturer. Seconds, rejects, or damaged materials will be rejected by CONTRACTOR. ENGINEER reserves the right to disapprove and reject any materials, proposed or installed which fail to meet these quality standards. CONTRACTOR shall, at his own expense, remove and replace with approved materials, any materials which do not comply with these standards.
- F. Electrical equipment furnished under Division 15 of these Specifications shall be in full compliance with Division 16 of these Specifications.

2.02 Fabrication

- A. Provide for possible adjustments in the field of mechanical work fabrications. Adjustments shall allow for adjustment to avoid interferences, installation of equipment or connecting to other Work.

2.03 Equipment

- A. General:
 - 1. Unless furnished as integral parts of mechanical equipment, appurtenances such as remote operation switches or push buttons, pilot lights, starter relays, overloads or other items shall conform to and be installed as specified herein and any related Sections.
- B. Electrical Service:
 - 1. Unless specified elsewhere, electrical service for equipment shall be either 480/277 volt, 3-phase, 60 HZ with 4 wire or 208/120 volt, 3-phase, 60 HZ with 4 wire. Lighting shall be 120 volt, single phase.
- C. Motors:

1. General: Electric motors furnished as a part of the mechanical equipment shall conform to the detailed provisions in Division 26.
2. Starters: Manual and magnetic starters furnished as a part of the mechanical equipment shall conform to the detailed provisions in Division 26.

2.04 Unit Heater

- A. Assembly: UL Listed assembly with terminal box and cover, and built in controls
- B. Heating Elements: helical coil of nickel-chrome resistance wire with ceramic support bushings
- C. Cabinet: 0.0478-inch steel with easily removable front panel with integral air outlet and inlet grilles
- D. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard
- E. Motor: Permanently lubricated, sleeve bearings, 1/15 HP, 1050 rpm, totally enclosed, shaded poles, 830 CFM
- F. Control: Separate fan speed switch and thermostat heat selector switch, factory wired, with switches built-in behind cover. Provide thermal overload.
- G. Electrical: 10kW, 208 volts, single phase
- H. Mounting: Install in accordance with manufacturer's directions. Hang from building structure with pipe hangers anchored to the building. Mount as high as possible to maintain greatest headroom.
- I. Acceptable Manufacturer: Modine Model HE100 or ENGINEER approved equal.

2.05 Wall Exhauster

- A. Performance:
 1. Air Flow.....360 cfm
 2. Static Pressure.....0.12 inches wg
 3. Power.....0.04 bhp
 4. Fan Tip Speed.....3297
 5. Electrical Characteristics.....1/25 hp, 115 volt, single phase
- B. Fan Unit: Direct drive with spun aluminum housing, resiliently mounted motor, ½-inch mesh screen, 0.062-inch thick aluminum wire bird screen
- C. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor, and wall mounted multiple speed switch.
- D. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked.
- E. Motor: 1/25 hp, 115 volt, open drip proof, 1550 rpm.

- F. Install in accordance with manufacturers instructions. Secure wall exhausters with stainless steel lag screws to structure. Install backdraft dampers and safety screens on inlet to wall exhausters.

Part 3 Execution

3.01 CONTRACTOR's Verification

- A. Verify location for installation of mechanical Work by field checking proper placement, possible interferences, and points of connection or termination.
- B. Verify opening clearances required for unobstructed passage of equipment or fabricated Work. Large equipment or fabrications shall be installed before buildings or structures are installed or completed.
- C. Additional cost for extra Work and/or delay in the Work because of failure by CONTRACTOR or a Subcontractor to verify locations, field conditions, or obstructions shall not be the responsibility of OWNER.

3.02 Installation

- A. Structural Cutting:
 - 1. Cutting of walls, floors, etc., for the installation of mechanical Work shall be done only when approved by ENGINEER. CONTRACTOR may allow Subcontractors to do minor cutting and patching, however, major cutting and repair shall be made by CONTRACTOR.
- B. Equipment:
 - 1. General:
 - a. CONTRACTOR's attention is directed to the fact that certain equipment, (fans, drives, and other machinery), must be installed before housing and/or enclosures are installed or completed. Doors and other access openings in some cases are not large enough to permit passage of the equipment completely assembled. CONTRACTOR shall thoroughly investigate these conditions prior to fabrication or shipment.
 - b. Component parts furnished as part of a packaged equipment system shall be installed with the mechanical Work, ready for connection as specified in Section 26 500, Common Work Results for Electrical. Electrical connection between component mechanical parts shall be inclusive to mechanical Work.
 - c. Components such as remote operation controls, pilot lights, overloads or others not furnished as integral packaged pieces of equipment shall conform to and be installed as specified in Section 40 9000, Process Instrumentation, Controls, and Monitoring Equipment.
 - 2. Supports and Anchors:

- a. Provide bases, pads, platforms, hangers, clamps, or embedded inserts necessary for proper support and/or anchoring of mechanical Work. Inserts to be embedded in concrete shall conform to and be installed as specified in Sections 03 3000, Cast-in-Place Concrete and Section 03 2000, Concrete Reinforcement. Detailed specifications for anchoring are included in other Sections of these Specifications.
 - b. CONTRACTOR will provide and install concrete foundations, bases and/or pads under each piece of mechanical equipment and machinery. CONTRACTOR will also install all anchor bolts and anchor bolt sleeves for said mechanical equipment and machinery.
 - c. CONTRACTOR shall be responsible for the proper sizes, locations, and quantities of these bases and pads where same are to be on concrete floor slabs, and shall provide all anchor bolts, sleeves, and setting templates for the mechanical equipment and machinery. Bases and/or pads are to be provided for each piece of mechanical equipment and machinery whether shown or not shown on the drawings.
 - d. Mechanical equipment resting on concrete foundations, bases or pads shall rest on a level and uniform bearing surface with grout when vibration isolation is not required or specified. Grout shall be nonshrink, nonstaining Type V as specified in Section 03 1500, Concrete Accessories.
- 3. Electrical Service:
 - a. CONTRACTOR shall furnish all motors required in connection with his Work and he shall mount or install all his motors in their finished locations.
 - b. Electrical components required and furnished for mechanical equipment systems provided as complete system by the manufacturer or Mechanical Subcontractor, and automatic temperature control systems together with any power and control interface wiring shall be the responsibility of CONTRACTOR. He shall perform this Work in accordance with requirements of the electrical Specifications. CONTRACTOR shall be responsible for the proper operation of his equipment and shall furnish all wiring and control diagrams to ensure proper operation of same.
- C. Painting:
 - 1. Painting of installed piping, ducts, or equipment shall be in accordance with Section 09 9100, Painting.
- D. Sleeves:
 - 1. Provide sleeves where pipes or ducts pass through walls or floors necessary for installation and as specified elsewhere for mechanical Work. Sleeves for covered pipe or ducts shall be of proper size to allow the covering to pass through unless otherwise directed or specified elsewhere.
- E. Plates:

1. Ceiling, floor or wall plates shall be installed at points where exposed pipes pass through walls, ceiling, or floors. Plates shall be nickel-plated sectional, pressed steel plates with positive catches.

F. Lubrication of Equipment:

1. After installation of any equipment is complete such as motors, pumps, compressors, etc., which depends on lubrication for efficient operation, they shall be lubricated in accordance with the manufacturer's recommendations. Lubrication shall be done before any test runs will be permitted or equipment placed in final operation.

G. Identification:

1. Mechanical equipment including pumps, air handling units and each and every valve and regulator shall be identified in accordance with other Sections of these Specifications.

H. Welding:

1. Material shall be clean either by wire brushing or by sandblasting, if needed, prior to welding, depending upon the condition of the material. If grease or other foreign materials of the same nature are present, cleaning shall be done by a suitable solvent.
2. Black steel pipe and fittings may be welded by either oxyacetylene or electric arc method.
3. Welding shall be done by first class pipe welders meeting qualifications covered by the American Standard Code for Pressure Piping (ASA B31.1). Welding shall conform to the standards and requirements of this code and all applicable state and local codes. OWNER reserves the right to require qualifying demonstrations of any welder assigned to the job by CONTRACTOR.
4. Branch connections shall be made with welding tees. Welding ells shall be used for changing pipe directions. Scarf welding of branch pipe connections and use of mitered joints shall not be permitted.
5. Slag, dirt, and loose pieces of metal shall be removed from the interior of the vessels, jackets, nozzles and piping. Welds are to be thoroughly cleaned and wire brushed, and weld spatter removed. Grinding of finished welds is not desired except where specified.

3.03 Field Quality Control

A. Testing:

1. During and after installation, those tests required by the local, county and state inspection bureaus, OWNER or ENGINEER, shall be performed in strict accordance with the department concerned and at the full expense of CONTRACTOR.

2. CONTRACTOR shall furnish all equipment, water, compressed air, apparatus, and labor necessary for the test. Defects disclosed by the tests shall be rectified by CONTRACTOR without cost to OWNER. Test shall be made under the direction of and subject to the approval of OWNER or ENGINEER. Tests required after installation are outlined herein and shall endure for not less than 48 hours.
3. Equipment shall be tested as in normal operating service unless specific rating tests are required as results of questionable performance.
4. Gages and equipment, etc., which may be damaged by the tests shall be valved off or removed before testing.
5. Special tests required for certain apparatus are specified under the specific headings for that apparatus.
6. In general, all visible or audible leaks shall be fixed regardless of previous testing results.

B. Final Inspection:

1. Upon completion of the Work, CONTRACTOR shall conduct a complete inspection of all items of Work instituted by the Contract obligations; and make whatever corrections and adjustments deemed necessary to a well functioning system, same to meet the satisfaction of ENGINEER and OWNER.
2. CONTRACTOR shall signify his readiness for final inspection in writing to ENGINEER. Time of inspection may occur at the time of "Operating and Instructions." Inspection shall be made in the presence of OWNER and ENGINEER.

C. Equipment Start-Up:

1. After completion of the installation, systems and equipment shall be tested by CONTRACTOR in the presence of ENGINEER under actual operating conditions. Tests shall be performed according to manufacturer's recommendations.
2. CONTRACTOR shall include with his bid the services of all required equipment manufacturer's field service technician for a period necessary to complete the work to the satisfaction of ENGINEER and OWNER.
3. This service shall be for the purposes of check-out, initial start-up, certification, and instruction of plant personnel.
4. A written report covering the technician's findings and installation approval shall be submitted to ENGINEER covering all inspections and outlining in detail any deficiencies noted.
5. Specific requirements, if any, for a particular system or piece of equipment are contained in the particular specification sections. CONTRACTOR's responsibility relative to coordinating these services are contained in Section 01 7000.

3.04 Cleaning and Adjustment

- A. Before turning the building(s) over to OWNER, clean all fixtures, piping, covering, exposed metal surfaces and leave in clean condition at the end of the Work and remove from the premises refuse, dirt and rubbish which are a result of the mechanical Work or workmen. Also, remove from the premises all cartons, scrap, and major debris at least once a week during progress of the Work.
- B. Upon completion of the plumbing system(s), CONTRACTOR shall adjust regulating valves for fixtures and equipment, etc., to provide proper and adequate flow.
- C. Instruments used in the checking, adjusting, and balancing shall be accurately calibrated and maintained. Accuracy tests on instruments shall be performed in the presence of and whenever requested by OWNER or ENGINEERS.
- D. After the cleaning and decorating of the buildings has been completed, CONTRACTOR shall thoroughly clean heating units, unit heaters, including coils and filters, elements, and inside of enclosures to completely remove the construction dust and dirt from same.
- E. Flush and clean the heating apparatus and system(s) for not less than four hours, using a standard accepted cleaning compound.
- F. Air and water balance and checking shall not begin until the system(s) has been completed and is in full working order. CONTRACTOR shall put heating, ventilating, and air conditioning systems and equipment into full operation and shall continue the operation of same during each working day of testing and balancing.
- G. Two weeks after turning the systems over to OWNER, CONTRACTOR shall return to the building(s) and clean and check strainers, controls, and accessories.

End of Section

Section 23 0553

Identification for Mechanical Piping and Equipment

Part 1 General

1.01 Scope of Work

- A. This Section includes methods for identifying mechanical piping and equipment, including equipment labels, pipe labels, valve tags, valve schedules, and warning tags.

1.02 Submittals

- A. Shop Drawings and product data shall be submitted in accordance with Section 01 3300, Submittal Procedures, for each type of product indicated in this section.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Valve numbering scheme.
- D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.03 Reference Standards

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for viewing angles of identification devices for piping.

1.04 Coordination

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.

Part 2 Products

2.01 Equipment Labels

- A. Plastic Labels:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16-inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: White.
 - 3. Background Color: Black.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 degrees Fahrenheit.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 1-1/2 by 4 inches.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content:
1. Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

2.02 Pipe Labels

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: At least 1-1/2 inches high.

2.03 Valve Tags

- A. Valve Tags: 0.032-inch thick brass.
 1. Data: Service, identification number, and temperature of the line controlled.
 2. 1-inch x 2-1/2 inch with lettering 5/16 inch high.
 3. Fastener: Brass chain or S-hook.

2.04 Valve Schedules

- A. Assign and tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), temperature, pressure, size, and variations for identification. Mark valves for emergency shutoff and similar special uses. Mount valve schedule in frame with clear plastic cover, include mounting screws.

2.05 Warning Tags

- A. Warning Tags: Preprinted plasticized card stock with matte finish.

1. Size: 4 by 7 inches.
2. Fasteners: Brass grommet and chain.
3. Nomenclature: Large-size primary caption such as "LABORATORY WATER, DO NOT DRINK"
4. Color: Yellow background with 1/2-inch black lettering.

2.06 Plumbing Fixtures

- A. Labels for non-potable fixtures shall have black 1/2-inch lettering and yellow background on self-adhesive waterproof paper, plastic or vinyl.
- B. Labels for potable fixtures shall have white 1/2-inch lettering and sky blue background on self-adhesive waterproof paper, plastic or vinyl.

Part 3 Execution

3.01 Preparation

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 Equipment Label

- A. Install or permanently fasten labels on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible.
- B. Locate equipment labels where accessible and visible.
- C. Include nameplates for the following general categories of equipment:
 1. Fuel-burning units, including boilers, furnaces, and heaters.
 2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
 3. Heat exchangers, electric coils, evaporators, cooling towers, heat recovery units, and similar equipment.
 4. Fans, blowers and air terminals.
 5. Air handling units.
 6. Packaged units.
- D. Equipment Marker Installation: Install with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.

3.03 Pipe Label

- A. Piping Color-Coding: Painting of piping is specified in Division 09.

- B. Locate pipe labels where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as removable accessible ceiling shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:
1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. At least once in each space, at least once every 20 feet, spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Anchor piping labels at each end with adhesive arrow bands around the full circumference of the pipe and overlapping at the ends. Adhesive arrow bands shall have a background color that is coded in accordance with the following table. If the stated background color is not commercially available, incorporate arrows into the label and provide color-coded bands without arrows.

Service	Background Color
Condensate	Orange
Heating Hot Water	Tan
Central Cooling Water	White
Potable Cold Water	Dark Blue
Lab Cold Water	Light Blue
Potable Hot Water	Bright Yellow
Lab Hot Water	Dark Yellow
Gas	Green
Air, RO/DI, Vacuum, Chemical Waste and Vent	Black
Fire Service	Red
Waste, Soil, Vent, Rain Leader	Brown

- D. For liquid piping systems, indicate on the labels whether they are supply or return pipes.
- E. For cooling water pipes connected to the campus tunnel system, state "Central Cooling Water" on the labels. For chilled water pipes connected to a chiller within the building, state "Chilled Water" or "Process Chilled Water" on the labels.
- F. Indicate pressures on labels for steam lines with pressure greater than 20 psig and on all gas lines (such as nitrogen, compressed air, etc.) over 30 psig.

- G. Orient adhesive labels parallel to the pipe and locate labels where they can be read from the floor or the most likely approach for access.
- H. Where exposed pipes in occupied areas are to be painted, the color will be specified by the Architect for aesthetic purposes. The term “exposed” in this context means unhidden by architectural elements, not uninsulated.
- I. On all piping, apply labels stating “asbestos free” at least once in each space, at least once every 20 feet, and within 6 inches of each point of connection with existing piping insulation. Mark the circumference of the new insulation with a black marking pen at each point of connection with existing insulation and draw an arrow from the nearest “asbestos free” to the black line. On the arrow, write with the black marker “terminates here.”
- J. Connect piping to appliances using manual gas shutoff valves, appliance pressure regulators, and unions. Install valve within 72 inches of each gas fired appliance and equipment. Install union between valve and appliances or equipment.
- K. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

End of Section

Section 23 0900 HVAC Control Systems

Part 1 General

1.01 Scope of Work

- A. Control Systems Work, including control sequences, as indicated on Drawings and by requirements of this Section.

1.02 Related Work Specified Elsewhere

- A. Refer to Division 26 Sections for the following Work:
 - 1. Power supply wiring from power source to power connection on controls and/or unit control panels. Include starters, disconnects, and required electrical devices, except where specified as furnished or factory installed by manufacturer.
 - 2. Interlock wiring between electrically operated equipment units and between equipment and field-installed control devices.
 - 3. Interlock wiring specified as factory installed, is Work of this Section.
- B. Provide the following electrical work as Work of this Section, complying with requirements of Division 26.
 - 1. Control wiring between field-installed controls, indicating devices and unit control panels.

1.03 System Description

- A. Temperature Control Sequence of Operation:
 - 1. Temperature control sequences of operation are indicated on Drawings.
 - 2. Exhaust fans and automatic dampers shall be interlocked as follows:
 - a. Filter Room: An adjustable cooling thermostat, upon a call for cooling, will open damper AD-1 and energize wall fan WF-1. A second cooling thermostat will control damper AD-2 and wall fan WF-2 in a similar manner. Thermostat subbase shall include FAN ON/AUTO modes of operation.
 - b. Unit heaters shall be energized with a drop in room temperature by the wall- or unit-mounted thermostat.

1.04 Submittals

- A. Shop Drawings and Product Data:
 - 1. Shop Drawings: Submit in accordance with Section 01 3300, Submittal Procedures, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

2. Manufacturer's technical product data for each control device furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes. Include installation and start-up instructions.
3. Shop Drawings for each control system containing the following information:
 - a. Schematic flow diagram of system showing fans, coils, dampers, and control devices.
 - b. Label each control device with setting or adjustable range of control.
 - c. Indicate all required electrical wiring. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.
 - d. Complete written verbal description of sequence of operation for each system.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01 6000, Product Requirements, operation and maintenance manuals for items included under this Section.

1.05 Quality Assurance

- A. Reference Standards:
 1. Electrical Standards: Provide electrical components of control systems, which have been UL listed and labeled, and comply with NEMA standards.
 2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for control systems.
 3. NFPA Compliance: Comply with NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," where applicable to controls and control sequences.
- B. Manufacturer's Qualifications: Firms regularly engaged in manufacture of control equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.

1.06 Service and Warranty

- A. Under Temperature Control all thermostats, control valves, motors, and other equipment provided under this Contract shall be adjusted. The equipment shall be placed in complete operating condition subject to the approval of ENGINEER, and the operating personnel shall be instructed in the operation of the control system.
- B. The control system as shown on Drawings and specified herein shall be guaranteed free from defects in workmanship and material under normal use and service for a period of 1 year after acceptance of ENGINEER.
- C. Equipment described herein proven to be defective in workmanship or material during the warranty period shall be adjusted, repaired, or replaced by the manufacturer at no charge to OWNER.

1.07 Delivery, Storage, and Handling

- A. Provide factory shipping cartons for each piece of equipment and control device. Maintain cartons while shipping, storage, and handling as required to prevent equipment damage and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.

Part 2 Products

2.01 Manufacturers

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Line Voltage Thermostat:
 - a. Honeywell, Model T6051A.
 - b. Robertshaw.
 - 2. Automatic Dampers:
 - a. American Warning and Ventilating.
 - b. Honeywell.
 - c. Ruskin.

2.02 Materials and Equipment

- A. Provide control products in sizes and capacities indicated, consisting of dampers, thermostats, controllers, and other components as required for complete installation.
- B. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.
- C. Provide control systems with the following functional construction features:
 - 1. Temperature Control Equipment:
 - a. Electric Control Systems:
 - (1) Line Voltage Thermostat: Thermostats shall be line voltage bimetal type instruments and rated for 16 amps at 120V. Thermostats shall be provided with Fan-Off-Auto subbase and shall have a setpoint range of 46-84 degrees F and a fixed differential of 1-degree F.
 - 2. General Control Systems:
 - a. Automatic Dampers:
 - (1) Frame: 13-gauge galvanized steel minimum.
 - (2) Blades: 16-gauge galvanized steel minimum; 8-inch width maximum.

- (3) Bearings: Stainless steel, bronze, plastic, or nylon.
 - (4) Blade Seals: Synthetic elastomeric or neoprene, mechanically attached.
 - (5) Jamb Seals: Stainless steel flexible metal.
 - (6) Linkage: Face mounted.
 - (7) Leakage: 8 cfm per square foot maximum using a 48-inch by 48-inch damper with a 1-inch differential static pressure tested per AMCA Standard 500.
 - (8) Jackshaft: Minimum 3/4-inch galvanized steel.
- b. Operators: Provide operators for each automatic damper. Operators shall be selected to provide the torque necessary for proper operation and sealing. Multiple operators shall be installed, if necessary, for proper operation.
- (1) Electric operators shall be sealed motor units with oil-immersed gear train. Motor covers shall be removable without disturbing the conduit or field wiring. Modulating and 2-position motor operators shall be spring return.

Part 3 Execution

3.01 Acceptable Installers

- A. Installer's Qualifications: Firms specializing and experienced in control system installations for not less than 5 years.

3.02 Inspection

- A. Examine areas and conditions under which control systems are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.03 Installation of Control Systems

- A. Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings, and details shown on Drawings. All piping shall be concealed except in mechanical rooms or areas where other piping is exposed.

3.04 Adjusting and Cleaning

- A. Start-up, test, and adjust control systems in presence of Owners authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- B. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

- C. Final Adjustment: After completion of installation, adjust thermostats, motors, and similar equipment provided as Work of this Section.

End of Section

Section 23 3400

Fans

Part 1 General

1.01 Scope of Work

- A. This Section includes wall fans, as indicated on Drawings and Schedules and by requirements of this Section.
- B. Power supply wiring from power source to power connection on fan motors. Include starters, disconnects, and required electrical devices, except where specified as furnished or factory installed by manufacturer.
- C. Interlock wiring between fan units; and between fans and field-installed control devices.
 - 1. Interlock wiring specified as factory installed, is Work of this Section.

1.02 Submittals

- A. Shop Drawings and Product Data:
 - 1. Shop Drawings: Submit in accordance with Section 01 3300, Submittal Procedures, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - a. Assembly-type Shop Drawings showing fan dimensions, required clearances, construction details, and field connection details.
 - b. Manufacturer's technical product data for fans, including specifications, capacity ratings, fan performance curves with operating point clearly indicated, gauges and finishes of materials, dimensions, weights, accessories furnished, and installation instructions.
 - c. Indicate fan pressure volume curve and horsepower curve on fan performance curves.
- B. Manufacturer's electrical requirements for power supply wiring to fan units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.
- C. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01 6000, Product Requirements, operation and maintenance manuals for items included under this Section.

1.03 Reference Standards

- A. AMCA Compliance: Provide fans bearing the AMCA Certified Ratings Seal. Sound rate fans in accordance with AMCA 300, "Test Code for Sound Rating Air Moving Devices."
- B. ASHRAE Compliance: Test and rate fans in accordance with ASHRAE 51 (AMCA 210), "Laboratory Methods of Testing Fans for Rating."

- C. UL Compliance: Provide fans electrical components which have been listed and labeled by UL.

1.04 Quality Assurance

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of fans, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.05 Delivery, Storage, and Handling

- A. Deliver fans with factory-installed shipping skids and lifting lugs; pack components in factory fabricated, protective containers.
- B. Handle fans carefully to avoid damage to components, enclosures, and finish. Do not install damaged components; replace and return damaged components to fan manufacturer.
- C. Store fans in clean, dry place and protect from weather and construction traffic.
- D. Comply with manufacturer's rigging and installation instructions for unloading fans and moving them to final location.

1.06 Extra Materials

- A. Furnish to OWNER, with receipt, 1 spare set of belts for each belt-driven fan.

Part 2 Products

2.01 Manufacturers

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Greenheck.
 - 2. Jenn Fan.
 - 3. Loren Cook Company.

2.02 Equipment

- A. The equipment shall be factory built and factory tested. Repair or replace any items which fail to obtain specified performance. Fans shall be statically and dynamically balanced and tested.
- B. Fan ratings shall be based upon tests performed in accordance with the test code set up by the Air Moving and Conditioning Association. Each fan shall carry, near the manufacturer's nameplate, the seal authorized by AMCA indicating that the ratings are certified.
- C. On the fan performance curves, the fan volume selection point shall be a minimum of 15 percent greater than the volume at the peak of the pressure volume curve. Brake horsepower at the selection point shall not exceed 95 percent of the rated motor horsepower.

2.03 Wall Exhaust Fans (WF)

- A. Provide belt- or direct-drive units as noted on Drawings. Provide adjustable drives on belt-driven units. Provide centrifugal sidewall exhaust type with all aluminum construction.
- B. Wheels: Construct wheels with aluminum, backward-inclined, air foil-type blades, and tapered inlet shroud.
- C. Motors: Provide totally enclosed, fan cooled, premium efficiency motors. Motor and drive shall be enclosed in a weathertight compartment. Provide motors self-cooled by outside air drain through motor compartment. Motor compartment shall be completely separated from exhaust air stream. Provide disconnect mounted in the motor compartment.
- D. Accessories: Provide gravity-type backdraft dampers of aluminum with brass hinge pins and nylon bearings. Dampers shall close on a neoprene seal. Units in excess of 50 pounds shall be installed on hinged base to provide access for cleaning and servicing. Provide speed controller.

Part 3 Execution

3.01 Inspection

- A. Examine areas and conditions under which fans are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 Installation of Fans

- A. Install fans where indicated, in accordance with manufacturer's installation instructions, and with recognized industry practices to ensure that fans comply with requirements and serve intended purposes.
- B. Access: Provide access and service space around and over fans as indicated, but in no case less than that recommended by manufacturer.
- C. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring instructions submittal to electrical Installer.
- D. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 Sections. Ensure that rotation is in direction indicated and intended for proper performance. Do not proceed with fan start-up until wiring installation is acceptable to fan Installer.

3.03 Field Quality Control

- A. Upon completion of installation of fans, and after motor has been energized with normal power source, test equipment to demonstrate compliance with requirements.
- B. Where possible, field-correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment which cannot be satisfactorily corrected.

3.04 Adjusting and Cleaning

- A. Start-up, test, and adjust fans in presence of manufacturer's authorized representative.

End of Section

Division 26
Electrical

Section 26 0500

Common Work Results for Electrical

Part 1 General

1.01 Section Includes

- A. General electrical equipment and installation requirements.

1.02 Related Sections

- A. Section 01 4219: Reference Standards

1.03 Work Included

- A. CONTRACTOR shall furnish all labor, material, and equipment required for the installation of the electrical systems, 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. CONTRACTOR shall install and wire all remote mounted heating and ventilating thermostats, electrical components, and control panels furnished by the equipment suppliers in accordance with other Sections of these Specifications.
- C. CONTRACTOR shall install and wire all electric resistance heaters and any associated, remote mounted thermostats furnished under other Sections of these Specifications.
- D. CONTRACTOR shall provide and install all conduit and wire connections required between components of equipment and systems supplied under other Sections of these Specifications, where shown or indicated on the Contract Drawings.
- E. CONTRACTOR shall furnish and install complete secondary power distribution systems and modifications to existing secondary power distribution systems.
- F. CONTRACTOR shall furnish and install a complete lighting system.
- G. CONTRACTOR shall furnish and install complete auxiliary systems and existing auxiliary system modifications, as specified herein and as shown on the Contract Drawings.

1.04 Description of Systems

- A. Existing secondary power shall be 480 volts, 3 phase, 3 wire plus ground, 60 Hertz supplied from the existing MCC.
- B. Lighting system shall be 120/240 volts, single phase, 3 wire plus ground, 60 Hertz.

Part 2 Products

2.01 Materials and Equipment

- A. CONTRACTOR shall furnish and install all modifications to the existing power distribution system, together with all necessary supports, framing, hangers, and all other appurtenances. CONTRACTOR shall furnish and arrange for the setting of anchor bolts, channels, etc. which are to be set in the concrete. CONTRACTOR shall connect and make operable any and all electrical equipment whether or not it was furnished under other Sections of these Specifications. Work shall include, but is not limited to, the following items:
1. Variable Frequency Controllers
 2. Distribution Panelboards
 3. Electrical Equipment and Devices
 4. Raceway System
 5. Power Feeder and Branch Circuit Wiring
 6. Modifications to Existing Motor Control Centers
 7. Disconnect Switches
 8. Surge Protection Devices
 9. Grounding System
- B. CONTRACTOR shall furnish and install a complete lighting system, together with all necessary supports, framing, hangers, outlets, fixtures, panels, receptacles, and all other appurtenances. He shall furnish and arrange for the setting of anchor bolts, concrete inserts, etc. which are to be set in the concrete or in masonry walls. Work shall include, but is not limited to, the following items:
1. Dry Type Transformers
 2. Lighting Panelboards
 3. Raceway System
 4. Wiring
 5. Wiring Devices and Hardware
 6. Lighting Fixtures and Lamps

Part 3 Execution

3.01 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.

3.02 Short Circuit, Flash Hazard, And Protective Devices Coordination Analyses

- A. A power system short circuit analysis shall be provided by 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 existing MCC through the branch circuit protective devices.

- B. A flash hazard analysis shall be provided by 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 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 six (6) 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 the [primary switch, secondary switchboard, the primary switchgear, secondary unit substations, service entrance switch, automatic transfer switch, motor control centers, distribution panelboards, branch panelboards], and other significant locations throughout the [modified and added] 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 NFPA 70E-2015 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/cm^2) 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 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 from the sources shown on the Drawings. Obtain the existing analyses for the existing portions of the plant's electrical distribution from OWNER, as a basis for the additions and modifications.
- 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 prepared by persons experienced in the work.
- 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 CONTRACTOR at no additional cost to OWNER. Required field settings and adjustments shall be made on existing protective devices also.

3.03 Sequence of Construction and Demolition

- A. CONTRACTOR shall be responsible for coordinating and scheduling his work to minimize disruption of OWNER's facility operations. CONTRACTOR shall schedule all service interruptions at times as approved by OWNER and shall notify OWNER, at least 24 hours in advance, of any scheduled power interruption during construction.
- B. CONTRACTOR shall include all details of the sequencing of the above 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 OWNER. The schedule shall be submitted for approval prior to the start of work.

End of Section

Section 26 0510

Basic Electrical Materials and Methods

Part 1 General

1.01 Scope of Work

- A. Requirements specified in Section 26 0500, Electrical General Requirements, are part of this Section. This section forms a part of all other sections of Division 26, unless otherwise indicated.

1.02 Related Work Specified Elsewhere

- A. Section 03 3000: Cast-in-Place Concrete
- B. Section 26 0500: Electrical General Requirements

1.03 Submittals

- A. CONTRACTOR shall submit for ENGINEER's approval material lists, shop drawings, and factory test reports, to the extent required in this section and Section 26 0500, Electrical General Requirements.

Part 2 Products

2.01 Basic Equipment and Materials

- A. Automatic Transfer Switch (ATS) and Control:
 1. Provide and install an automatic transfer switch (ATS) as indicated on the plans. The ATS shall be provided with three poles for 480 volt, 3 phase, 4 wire, solid neutral 60 HZ. The ampere rating of each contactor shall be 3,000 amperes as indicated on the plans. The ATS shall have two bottom entry cable sources and a 2,500-ampere feeder (load) bus duct.
 2. The ATS shall include the necessary relays and component parts, together with UL listed and tested electrically and mechanically interlocked contactor, and shall provide the following functions:
 - a. Upon power line outage, automatically switch over to the alternate source, diesel generator.
 - b. Upon power line return, transfer the load back to the normal source after a time delay of 20 to 30 minutes.
 3. Each contact pole of the main transfer device shall be double break design, with solid silver cadmium contacts, capable of handling both non-inductive and inductive loads and allow for inrush currents of 20 times the continuous rating. Contact pressure shall be maintained by a coil spring, not a part of the current carrying path. The ampere rating of the transfer switch shall be sufficient to handle the loads being transferred. Switch shall conform to UL 1008 for transfer switches.

4. The transferred switch shall be double throw, actuated by two electrical operators. A time delay between the opening of the closed contacts and closing of the open contacts shall allow loads to be demagnetized before transferred.
5. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing.
6. The transfer switch shall include an in-phase monitor. This device is to monitor the normal and emergency sources and will not permit transfer in either direction until the phase voltages are within 15% and have a frequency difference within two cycles. If the source supplying the load fails or drops below 70%, the monitor will override itself and permit immediate transfer. Transfer switch can be furnished by Diesel Generator Manufacturer. Approved manufacturers are Russell Electric, ASCO, and Onan.

B. Wire Size and Insulation (Low Voltage):

1. Wire for branch circuits, including power and lighting shall consist of No. 12 minimum size copper conductors, type THHN, THW, XHHW or THWN, insulated with Underwriters' approved 600-volt insulation, and in accordance with the following:
2. Rubber and rubber-like insulated wire and cable shall be manufactured and tested in accordance with ICEA Publication No. S-19-81 (latest edition), NEMA Publication No. WC3.
3. Thermoplastic insulated wire and cable shall be manufactured and tested in accordance with ICEA Publication No. S-61-402 (latest edition), NEMA Publication WC5.
4. Cross-linked polyethylene insulated wire and cable shall be manufactured and tested in accordance with ICEA Publication No. S-66-524 (latest edition), NEMA Publication No. WC7.
5. Indoor lighting branch circuits and 120-volt receptacle circuits shall be single conductor solid copper, 600-volt insulation, Type "THW", "THWN", or "XHHW" moisture and heat resistant thermoplastic approved by N.E.C. for operating temperature of 75°C and for installation in wet or dry locations.
6. Type "XHHW" heat resistant wire shall be used for wiring of recessed fixtures, and between fixtures and their adjacent outlets.
7. For 480-volt standard service, single conductor stranded copper cable shall have corona, ozone, heat and moisture resistant cross-linked polyethylene 600 volt insulation, or approved equal, rated to withstand a copper temperature of 90°C. without deterioration. It shall meet applicable ICEA Standards, and be UL labeled XHHW.
8. Wire and cable, including feeders, main and branch circuits, shall be color coded as follows:

208 / 120 Volt		480 / 277 Volt	
Color	Phase	Color	Phase
Black	A	Brown	A
Red	B	Orange	B
Blue	C	Yellow	C
White	Neutral	Gray	Neutral
Green	Ground	Green	Ground

9. Conductors No. 8 and smaller shall have color coded insulation, Conductors No. 6 and larger shall have terminations and conductors in pull boxes taped with colored tape, not less than two inches wide.
10. Wire and cable shall be continuous in the same color code and type to its extreme termination point. The use of different type of insulated wire to the same device or equipment will not be accepted. Manufacturers shall be Anaconda, General Cable, General Electric, Okonite, Triangle, or equal.

C. Control Wiring:

1. Control circuit, single conductor field wire shall be No. 14 AWG, stranded copper with 30-mil thick wall of cross-linked polyethylene or polyvinyl chloride insulation rated to withstand a copper temperature of 90° C. at 600 volts without deterioration. It shall meet applicable ICEA Standards.
2. Multi-conductor control cable shall consist of individual conductors, No. 14 AWG, stranded copper with 30-mil thick wall of insulation rated to withstand a copper temperature of 75° without deterioration. The insulation shall be a 20-mil wall of polyethylene with a 10-mil thick polyvinyl chloride jacket. The individual conductors shall be identified per Paragraph 5.6.3. of ICEA Publication No. S-61402 and shall be cabled together with suitable fillers and binder tape to give the completed cable a substantially circular cross section.
3. An overall sheath of black polyvinyl chloride shall be applied to the cable and shall not be less than the following thickness:

No. of Conductors	Jacket Thickness
2 – 5	0.045"
6 – 14	0.060"
15 and above	0.080"

4. The entire cable shall meet applicable ICEA Standards and tests for thermoplastic insulated cables.
5. Control wires to be identified with vinyl wire markers.

D. Panel Wiring:

1. Panel wiring shall be a minimum 14 AWG-MTW, 60° rated for AC connections.

2. Thermoplastic wire cover shall be rated at 600 volts and be colored red for AC wires; light blue shall be used for DC wires; canary yellow shall be used for wires interconnecting with other control panels or systems which may be energized from alternate power source; green shall be used on all ground wire connections; black wire shall be used for power source and white shall be used for power neutral.
3. Instrument shields shall be connected to a common ground termination in the control panel. Shields shall not be grounded in the field.
4. No splices of either control or instrument wiring shall be permitted outside of termination points.
5. Wires comprising the various control systems for this installation shall be identified at each termination with wire identification tags.
6. Numbered tags shall be of the type manufactured of laminated mylar and be capable of withstanding temperatures to 300°F. without deterioration and discoloration.
7. Each wire number shall be "solid" preprinted and not pieced from single and/or double-digit tags.

E. Shielded Single Pair Cable:

1. For general shielded service, single-pair cables shall consist of two conductors, twisted together, served with a continuous aluminum mylar shield with grounding bleed wire and protected with an insulating jacket.
2. Individual conductors shall consist of a tinned, soft annealed copper conductor, stranded, insulated with a 24-mil thick wall of polyethylene. The twisted pair shall be color coded and sized as follows:
 - a. Runs under 400 feet - No. 16 AWG
 - b. Over 400 feet - No. 14 AWG

F. Multiple Conductor Shielded Cable:

1. This cable construction shall be an assembly of twisted pairs cabled together and served with an overall aluminum mylar shield with grounding bleed wire, with an extruded jacket of polyvinyl chloride having a thickness as follows:

Cable Size	Jacket
3 and 7 pair	60 mils

2. Portable cords shall consist of flexible, bunch stranded, plain annealed copper conductors with a 600-volt heat and moisture resistant rubber insulation suitable for operation with a 60 degrees Celsius copper temperature. Individual conductors shall be color coded for identification and cabled with suitable high strength fillers to give the completed cable a circular cross section.

G. Conduits and Fittings:

1. Conduits shall be manufactured in conformance with the latest published standards of ANSI, ASTM, and UL and shall be as follows:
2. Rigid and intermediate steel conduit, conduit bends, elbows, couplings, and nipples shall be hot-dipped galvanized. Buried rigid steel conduit shall be plastic coated galvanized steel conduit. Couplings and connectors shall be threaded type.
3. Conduit terminations shall consist of double locknuts and insulated bushing, raintight connectors, or threaded hubs as applicable to maintain the rating of the enclosure to which it is being terminated.
4. Joints in conduits shall be made with standard couplings unless neither conduit can be turned; then, union shall be made with O.Z. Type "SP" split coupling or Erickson couplings. Running threads are not permitted.
5. Conduit expansion fittings shall be O.Z. Type "DX" with bonding jumper, as required.
6. PVC conduit material shall have tensile strength of 7,000 psi at 73.4 degrees Fahrenheit, flexural strength of 11,000 psi, and compressive strength of 8,600 psi.
7. PVC conduit fittings and covers shall be of the same manufacturer as the PVC conduit.
8. Flexible liquid tight conduit shall be provided for connections to vibrating or rotating equipment. Conduit shall be Anaconda Type "UA" for 3/4-inch to 1-1/4 inch and Type "EF" for 1-1/2-inch and larger, flexible conduit, with Appleton STN series fittings, as required.
9. Flexible steel conduit similar to "Greenfield" shall not be permitted.
10. Conduits installed in "hazardous areas" shall be approved for the Hazardous Class Division and Group as required by NEC and identified on the Contract Drawings.

H. Pull Boxes:

1. Pull boxes, junction boxes, and cable support boxes of proper size and design shall be provided in accordance with the N.E.C. and as required to facilitate installation of wires. Boxes shall be sized in accordance with the N.E.C. Covers shall be gasketed and held in place with corrosion resistant machine screws. Cable supports for vertical runs shall be provided at code required locations, within pull or junction boxes. Boxes shall be NEMA 12 for inside and NEMA 4 for outside use where exposed to the weather or where otherwise called for on the Contract Drawings.
2. Pull boxes located in "hazardous areas" shall be in strict accordance with National Electric Code requirements for the type of area classification and as identified on the Contract Drawings.

I. Outlet Boxes:

1. Cast steel outlet boxes shall be used for every outlet and switch where called for on the drawings and as herein specified. All cast boxes shall meet the requirements for galvanized finish specified for steel conduits.
2. All outlet boxes for exposed work shall be of cast steel construction with threaded openings Type "FS" or "FD" unless noted otherwise.
3. Provide temporary caps on boxes similar to Gedney, "Red Caps" during construction.
4. Outlet boxes installed in hazardous areas shall be approved for the Hazardous Class, Division and Group as required by NEC and identified on the Contract Drawings.

J. Receptacles:

1. In general, receptacles shall be duplex convenience grounding type with weathertight gasket and covers and shall be installed in exposed cast metal conduit boxes type FD with mounting ears. This also includes receptacles used for disconnects.
2. Convenience receptacles shall be rated 20 amps with back and side wiring and with exposed metal parts finished to resist corrosion.
3. Special purpose receptacles shall be rated 20 amps, 230 volts, unless otherwise called for on the Contract Drawings.
4. Weatherproof duplex receptacles shall have a separate spring type cover for each receptacle mounted on a FS or FD box.
5. Receptacles in wet well, kitchens, bathrooms, and as indicated on the drawings shall be provided with ground fault circuit interrupting breakers.
6. Explosion proof receptacles shall be 20 ampere, 2 wire, 3 pole, 120 volts, Killark KRS-215-220 Appleton Crouse-Hinds or equal. Supply one matching plug each.

K. Light Switches:

1. Switches shall be "T" rated. Switches, and receptacles shall be specification grade and as called for on the Contract Drawings.
2. Covers shall be stainless steel unless otherwise called for on the Contract Drawings.

L. Switch and Receptacle Plates:

1. Plates for switch, receptacles, telephone, and miscellaneous signal outlets shall be .040 inches stainless steel with No. 4 finish in all areas unless otherwise noted.
2. Cadmium plated steel plates shall be installed in equipment space and process areas.

3. Grouped devices shall be mounted in a single continuous gang plate.

M. Lighting Fixtures:

1. CONTRACTOR shall furnish all materials and equipment required to install and place in operation all fluorescent, metal halide, high pressure sodium and incandescent fixtures.
2. Lighting fixtures shall be complete, including all lamps and/or tubes, ballasts, fuses, support brackets and other parts and devices necessary for complete operation.
3. The lighting fixtures shown on the plans are selected for type and standard of quality. Other manufactures may be acceptable if approved by ENGINEER in accordance with the requirements for "substitutes" in the General Conditions.
4. Lighting fixture supports and conduit connections and fittings shall have corrosion resistant qualities.
5. Underwriters' labels - all fixtures, signs, etc., shall carry the approval of the Underwriters Laboratories, Inc., and be so labeled.

N. Lamps:

1. CONTRACTOR shall furnish and install all lamps for all types of lighting fixtures as shown on the schedules and drawings. Fixtures shall be cleaned, and all lamps shall be relamped at the end of the job. See Article 3.05 for adjustment and cleaning.
2. Fluorescent lamps shall be rapid start, 48-inch, 34-watt, cool white type T-12. The average life shall be approximately 15,000 hours and the initial light output shall be 3,000 lumens.

O. Ballast:

1. Ballast shall be an integral part of the fixtures as specified on the Contract Drawings.
2. Ballasts shall be high power factor, non-PCB, E.T.L. certified and shall carry Certified Ballast Manufacturer's and Underwriters Laboratories' labels.

P. Exit Light:

1. Exit fixtures shall be of a type suitable for the location in which they are installed and shall be single or double-faced, top or end mounted with directional arrows. Exit fixtures shall be of thin die cast aluminum frame type with stenciled letters of size and color required by local code. Exit lights shall have an automatic, rechargeable battery backup for continuous illumination during power failure.

Q. Emergency Lighting:

1. Emergency lighting shall be of the battery-operated type equipped with reliable type of rechargeable batteries provided with suitable facilities for maintaining the batteries in properly charged conditions.
2. Emergency lighting system shall be capable to maintain a lighting level not less than 1-foot candle for a period of 1-1/2 hours in the event of failure of the normal lighting.

R. Motor Starters:

1. 3-Phase Starters:
 - a. Starter for each 3-phase single speed motor shall be on the nonreversing across the line combination magnetic type, minimum size 1 with magnetic circuit breaker and control transformer.
 - b. Circuit breaker shall be externally operated, interlocked to prevent opening the cover when the switch is closed.
 - c. Starter shall have, in addition to a holding circuit contact, two auxiliary contacts.
 - d. Control transformer shall be rated 480 volts to 120 volts with fused secondary, minimum 50 VA but of sufficient capacity to service the starter coil plus such auxiliaries as may be indicated. Each starter shall be provided with wiring and schematic control diagrams which applies to the unit it serves.
2. Single Phase Starters:
 - a. Starters for single phase motors shall be manual type, with overload protection and on-off switch.

S. Variable Speed Adjustable Frequency Controller:

1. Variable Speed Adjustable Frequency Controllers shall be provided by the manufacturer of the driven equipment, in the number and sizes required by specification in Divisions 40 and 44 of the Contract Documents.
2. Variable speed power unit shall be an adjustable frequency controller which will convert 460-volt, 3 phase, 60 HZ, input power into an adjustable frequency output in an ambient temperature of zero to 40 C. Output power shall be of suitable capacity and waveform, with harmonic current content less than 5% of the fundamental, to provide stepless speed control of the specified horsepower throughout a continuous speed range under variable torque load not exceeding the motor's full-load rating.
3. Controller shall be of the constant voltage source type, with diode rectifier section, inductor and capacitor filtered DC link, and PWM (pulse width modulation) inverter using GTO (gate turn off) thyristor.

4. Variable speed power unit shall include an isolation contactor and bypass combination starter with circuit breaker, overload relay and VFC-Off-Line three position selector switch.
 - a. This equipment is provided to isolate and bypass the variable frequency controller in the event of malfunction and to run the pumps at full voltage.
5. The controller shall be in accordance with the following:
 - a. Input Power: 460 VAC, 3 phase, 60 HZ +10%-5%
 - b. Output Power: 0-460 VAC
 - c. Output Frequency: 1.5 to 60 HZ
 - d. Output Waveform: Sine Coded PWM
 - e. Control Power: 120 VAC (from Control Transformer)
 - f. Speed Control:
 - (1) Manual: 5K ohm 1/2 watt Potentiometer
 - (2) Auto: 4-20 mA DC into 630 ohm impedance
 - g. Operating Temp: 32 F to 104 F (fan cooled)
 - h. Rel. Humidity: Maximum 95% noncondensing
 - i. Acceleration: Adjustable 1 to 60 seconds
 - j. Deceleration: Adjustable 1 to 60 seconds
 - k. Current Limit: Adjustable 60 to 120% of rated output current
 - l. Overload Trip: Adjustable 0 to 100% of rated output current
 - m. Instantaneous Overcurrent: 250% of rated output current
 - n. Ground Fault: Nonadjustable trip
 - o. Overtemperature: Heatsink thermal switch
 - p. Over Voltage: DC bus monitor trips at 900V DC
 - q. Under Voltage: AC line monitor trips at 87.5% and resets at 95% of rated input voltage
 - r. Speed Indicator: Digital 0 to 100% of rated speed
 - s. Voltmeter: Digital 0 to 600 volts
 - t. Ammeter: Digital-amps range 0 to 150% of rated current
6. Diagnostic/Status Indicator Module shall include the following:
 - a. Under Voltage: Drive Lockout
 - b. Over Voltage: Power Supply OK
 - c. Ground Fault: Motor Current Limit
 - d. Instantaneous Overcurrent: Power Up Delay
 - e. Shoot Through: Drive Enabled
 - f. Overtemperature: Bus Under Voltage
 - g. Overload: Gate Driven Boards Functioning Overload Timer
 - h. Enclosure: NEMA 12 Motor Control Center Section
 - i. Manufacturer: Square "D" Class 8804, Omegapak Type VT, or equal

T. Nameplates:

1. Safety switches, lighting panels, starter enclosures, panelboards, etc., nameplates shall be of laminated white plastic with black lettering and shall be attached with sheet metal screws. Nameplates size shall be 2 1/2" wide x 3/4" high. First line character size 1/4-inch high, second line 3/16-inch high. For panel designations, refer to electrical panel schedule on drawings. Panelboards shall contain a typed circuit schedule inside of cover.
2. Field located instruments and devices shall be equipped and identified with 1" x 3" engraved nameplates (similar to the panelboard nameplates) and affixed to their respective devices in a positive but flexible method (wire strap or other similar means).

2.02 Mixes

- A. Patches, conduit sealing compound, fire stop compounds, etc., shall be mixed in accordance with the manufacturer's recommendations.

2.03 Fabrication and Manufacture

- A. CONTRACTOR shall, to the degree possible, preassemble switchgear, panel boards, motor control centers, control panels, relay panels, etc.
 1. Preassembly should be done off site in a clean shop environment by CONTRACTOR or manufacturer.
- B. Control panels, motor control centers, and switchgear shall be fabricated in sections not exceeding 10 feet in length and provided with jumpers for field connections of bus and interconnecting wiring.
 1. Panels shall be provided with adequate lifting eyes.

2.04 Equipment

- A. Electrical devices furnished under this Contract will be of the most recent manufacture and received at the job site in the manufacturer's shipping container which clearly identifies the item.
- B. Only new electrical equipment will be acceptable. Used, rebuilt, or discontinued models will not be accepted for installation under this Contract.

2.05 Acceptable Manufacturers

- A. Only manufacturers recognized as producing new, top quality products meeting applicable standards will be considered acceptable.
- B. ENGINEER may require CONTRACTOR to furnish acceptable material from other sources of supply, if he finds the Work will be delayed or adversely affected in any way because the stated source of supply cannot furnish a satisfactory product in sufficient quantities or if it is known to be unsuitable for the purpose for which it is proposed to be used. CONTRACTOR shall have no claim for additional compensation because of such requirement.

Part 3 Execution

3.01 Contractor's Verification

A. General:

1. Dimensions which tie mechanical and/or electrical installations to the building structure shall be thoroughly field checked for accuracy and possibility of interference due to field conditions. Ignorance of such field conditions because of CONTRACTOR's failure to field check the dimensions in question will be no excuse for additional compensation.

B. Surveys:

1. CONTRACTOR shall lay out and establish the lines and grades of all underground conduits on the site in accordance with the drawings and he shall employ a competent surveyor for this portion of the work.
2. In the event of unforeseen obstructions, CONTRACTOR shall confer with ENGINEER and obtain his written approval before proceeding with any work deviating from the governing drawings. CONTRACTOR shall assume full responsibility for locations and grades throughout this portion of the Work.

C. Locations:

1. Wall outlets, telephone outlets, clock outlets, specialized outlets, fixtures, and equipment rough-ins shall be field located except as otherwise shown on the drawings.

D. Points of Termination:

1. The points of connection and termination of related work under this Division of this Project are indicated on the Plans or stated in the Specifications, but in case of doubt as to such points of connection or termination, the decision of ENGINEER shall be final.

3.02 Preparation

- A. Conduit, fittings, and accessories shall be free of foreign matter. Conduit ends shall be reamed and deburred to prevent damage to the wire and cable.

3.03 Installation

A. General Requirements:

1. Electrical system layouts indicated on the Plans are generally diagrammatic and locations of outlets and equipment are approximate. Exact routing of conduits and wiring, locations of outlets and equipment shall be governed by structural conditions and obstructions. Equipment requiring maintenance shall be located and installed so that it shall be readily accessible.
2. CONTRACTOR shall not burn, cut or drill structural steel for the installation of conduit in any manner except where written permission is granted by ENGINEER.

3. Wiring shall be installed in raceway, including low voltage work, except where otherwise shown or specified.
4. Minimum conduit size shall be 3/4-inch unless noted otherwise.
5. Conduit shall be installed to be concealed wherever possible, unless otherwise indicated. In unfinished mechanical equipment rooms where the exact location of ventilation ducts, etc., is not shown, install the conduit exposed and avoid interferences.
6. Conduits shall be separated by at least 12 inches from parallel runs of steam or hot water piping.
7. Rigid steel conduit shall be used for exposed service drops in mechanical equipment and process area rooms, in exposed outdoor areas, except where another type of raceway is specified. Locknuts shall be steel or malleable iron (as size requires).
8. Conduit runs in floor slabs and direct buried underground between structures shall be rigid steel. Stub ups shall be rigid steel.
9. Where PVC conduit is permitted as noted on drawings, underground PVC conduit runs shall be installed on approved plastic spacers and encased in a 3-inch Granular Material envelope with red-oxide pigmented concrete over top. Envelopes shall have a yellow-colored, plastic, detectable caution tape buried a minimum of 12-inches above the conduit. Caution tape shall be labeled "Caution – Buried Electrical Lines".
10. Connections to vibrating or rotating equipment shall be made with flexible liquid tight conduit.
11. Provide expansion fittings at all expansion joints and/or where required to compensate for expansion and contraction in long conduit runs. Connectors shall be compatible with flexible conduit used.
12. Conduits shall be installed in floors and walls, wherever possible, unless otherwise indicated on the Plans or specified herein.
13. Empty feeder and riser conduits shall contain one No. 10 AWG galvanized steel pull wire. Splicing of the pull wire will not be permitted.
14. Conduit joints shall be set up tight. Runs shall be straight and true. Elbows, offsets, and bends shall be uniform and symmetrical.
15. Multiple conduit runs exposed shall be mounted with rustproofed steel supports arranged so that each conduit is individually clamped or bolted. Steel conduit supports shall be hot-dipped galvanized after fabrication.
16. Concealed conduits or outlets installed flush in masonry or concrete construction shall be rigidly braced against movement during the construction period to ensure accurate termination points.

17. Conduits hidden by suspended ceilings may be run exposed between ceiling construction and structural slab. Conduits, where exposed in service rooms, mechanical equipment rooms, etc., and other work areas, shall be racked in neat symmetrical lines with proper supports. Conduits shall be run at right angles and parallel to floors, ceilings, and walls.
18. Underground conduit shall be tested to determine that all fittings are completely sealed. The tests shall be performed during and after installation of conduit, but before cable is pulled and before any conduit is encased in concrete.
19. Ninety (90) degree bends 1-1/4 inches and larger shall be made with factory elbows. Elbows of 3-inch conduit size and larger shall be long radius. Field bends shall be made so that the conduit will not be injured, and the internal diameter shall not be effectively reduced. Factory elbows, nipples, and couplings shall be the same type as the conduit with which they are used.

B. Hazardous Locations:

1. Equipment, fittings, and wiring installed in hazardous areas, shall be approved by the N.E.C. for respective class and division which is applicable to area(s) where installed.
2. Sealing fittings shall be properly installed at all required locations in accordance with code regulations. Automatic drain conduit seals shall be used wherever necessary to ensure the prevention of moisture accumulation. Approved breathers shall be installed in appropriate locations.

C. Conduit Supports:

1. Conduit supports shall be suitably spaced and secured so as to provide adequate mechanical support and shall meet the code requirements. Supports shall be of steel bar, unistrut, angle or channel and of a size to provide a firm, rigid support. Fabricated supports and mounting brackets shall be hot dip galvanized after fabrication and drilling is complete. Rod hangers may be used when laterally braced. Structural steel flanges of I beams or channels shall not be drilled. Prefabricated sections may be used with approval of ENGINEER.
2. Electrical equipment including raceways, outlet boxes, panels, fixtures, etc., shall be substantially secured to the building structure. Inserts or insert bolts for support of the electrical equipment shall be installed during the building construction wherever practical.
3. Exposed multiple horizontal and vertical parallel runs of conduit shall consist of galvanized steel framing channels, conduit clamps, and rod hangers, where required, installed in accordance with the manufacturer's recommendation for the carried loads.
4. Where exposed isolated conduit needs clamping to flat surfaces, clamps shall consist of galvanized malleable iron, one-hole pipe straps for conduit up to and including 1-1/2 inches. Straps for conduits above 1-1/2 inches shall be two-hole, extra heavy steel. Steel bolts of appropriate size to fill the holes of the straps shall be used.

5. Conduit shall be supported in accordance with N.E.C.

D. Conduit Fittings:

1. Conduit fittings shall be made of a compatible material as the conduit. All conduit fittings with blank covers shall have rubber gaskets except in clean, dry areas and shall be accessible after the Work is completed.

E. Sleeves and Inserts:

1. CONTRACTOR shall provide all openings and sleeves on walls and floors as required for his work. Inserts shall be the tapered nut type with lead alloy expansive retainer sleeve. The use of wooden plugs will not be permitted.

F. Lighting:

1. Lighting fixtures shall be mounted level at the height as indicated on the Contract Drawings.

G. Taps and Splices:

1. Splices and taps shall be made by means of screw type pressure connectors. Spring pressure type connectors may be used for No. 10 AWG conductors and smaller. Instrument pigtail splices shall be made with solderless crimp type connectors.
2. Connections for No. 8 wire and larger to switches, panels, and controllers shall be made with solderless lugs of proper style and size to handle full wire capacity.
3. Stranded cable terminations shall be equipped with solderless lugs.
4. No splices outside of enclosures will be allowed. No splices except for lighting fixture and instrument pigtail connections shall be permitted unless specifically indicated on the Plans or written approval is given by ENGINEER.
5. Joints not supported and enclosed on terminal strips or equipment lugs shall be insulated with high-quality tape or material in an approved manner.

H. Wiring:

1. Wiring for power, lighting, telephone, sound, and low voltage control shall be run in one of the types of conduit described in these Specifications, unless indicated otherwise on the Plans.
2. Multi-wire branch circuits shall be color coded as stipulated in the National Electrical Code, and as herein specified.
3. Circuits feeding duplicate processing equipment shall be installed in separate conduits.
4. Instrumentation cable shall be run in conduits so as to isolate the cable from power or electrical wiring.

5. Cable insulation shall not be cut back beyond what is reasonably required to make connection, splice, or termination.
6. Wires and cables shall be tagged at both ends and in pull boxes or panel box gutters they pass through.
7. No conductors shall be pulled into any conduit run before all joints are made up tightly and the entire run rigidly secured in place.
8. Approved pulling-in compounds shall be permitted for ease of pulling cables. Pulling of cables shall in no way cause injury to conductors by elongation or to insulation by abrasion, binding, etc. Damaged cable shall be replaced.

I. Foundations:

1. The electrical subcontractor shall arrange with CONTRACTOR to provide concrete pad foundations for all floor-mounted equipment installed under this Division. Pad shall be four inches high, unless noted otherwise.

J. Access Panels:

1. Access panels or hatches shall be provided wherever electrical equipment concealed by the building construction requires access for inspection, operation, or maintenance. CONTRACTOR shall furnish all such panels required for access to his work. CONTRACTOR shall install all panels.
2. A subcontractor requiring access panels shall confer with CONTRACTOR in regard to access panel locations and shall, wherever practicable, group equipment requiring access such that a single panel will serve all and eliminate additional panels.

K. Grounding:

1. CONTRACTOR is responsible for providing all grounding, whether or not shown on the Plans, and all grounding shall be provided in accordance with NEC and local codes and ordinances. Grounding as shown on the plans is the minimum acceptable. Electrical grounding shall be grouped into two (2) classifications as follows: system grounding and equipment grounding.
 - a. System:
 - (1) Use of the metallic conduit or fittings or piping as a grounding path shall not be acceptable.
 - b. Equipment:
 - (1) Metal or conducting type enclosure frames, raceways, cable trays, conduit, panelboards, substation, motor frames, switches, switch boxes, outlet boxes, junction boxes, lighting fixture frames, building steel, metal siding, rebar, piping, etc., shall be grounded by a green colored or bare equipment grounding conductor of size called for in tables of the most recent applicable N.E.C. edition.

- (2) When a separate equipment grounding conductor is used, it must be contained within the same raceway or cable with the circuit conductors.
- (3) Grounding rods, hereinafter referred to as ground rods, shall be solid cylindrical rods, 3/4-inch in diameter and 10 feet in length, or longer, as required to reach specified resistance. Rods shall be of copper-clad steel tinned at top end for connection.
- (4) Resistance from the building ground loop to earth before connection to the building steel and the water system shall not exceed 2 ohms.
- (5) Bare copper bar, cables, or fittings used for grounding shall not be installed in cinder fill or covered with soil containing cinders or other corrosive materials. Cables shall be installed with enough slack to prevent stresses.
- (6) Where ground conductors pass through floor slabs, building walls, etc., and are not encased in rigid metal conduit as specified elsewhere, shall be provided with sleeves of transit, plastic, fiber or other approved nonmetallic material, and of the required size, shape, and length unless otherwise specified or indicated on the Plans.
- (7) Bonding jumpers shall be copper and of a cross-sectional area at least equal to their corresponding grounding conductors. 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, except where ground conductors are attached to lead cable sheaths.
- (8) Grounding mediums shall be bonded together. This shall include electric, telephone, antenna systems, ground and underground piping systems which enter the structure.
- (9) Compression connectors, lugs, etc., used in grounding circuits in any location shall have bolts, nuts, etc., of silicone bronze alloy metal. Ground connections, clamps, etc., shall be as manufactured by Burndy Engineering Company, Thomas & Betts Company, Penn-Union Electric Company, or equal.
- (10) The minimum number, spacing, and location of ground rods to be driven shall be per the site soil conditions during dry weather. Connections to ground rods shall be below finished grade level and shall be connected by a "cadweld", or other thermal process.
- (11) Use of the water system as the grounding electrode shall not be acceptable. However, the water system shall be grounded to the grounding system.

- (12) Taps and splices in grounding cables shall be made by the "cadweld", or equal process.
- (13) 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. 6 AWG with solderless lug on each end. Jumper shall be connected inside the box to a stud or silicone bronze alloy bolt in the cabinet frame.
- (14) Conduit expansion joints and telescoping sections of metal raceways not thoroughly bonded otherwise shall be provided with approved bonding jumpers of not less than No. 6 AWG stranded bare copper.

L. Electrical Equipment Identification:

- 1. Electrical devices shall be labeled in a clear and permanent manner to identify its electrical circuit.
- 2. Motor circuits shall have the functional description on motor starter panel and distribution panelboard doors, remote safety switches and manual switches.
- 3. Receptacles and wall switches shall be identified using the distribution panel "letter designation" and circuit breaker numerical assignment.
- 4. Motor starters, switch boards, and panelboards shall have laminated plastic identification nameplates attached to the unit with screws as specified herein. Other electrical devices shall be identified using 1/4-inch plastic adhesive-backed embossed tape securely fastened to the face of the device.

M. Painting and Finishing:

- 1. Concealed iron work, panel boxes, junction and pull boxes, and support boxes not galvanized shall be given one coat of rust resisting paint inside and out. In addition, junction boxes shall be given one coat of white enamel inside only.
- 2. Equipment which was finish painted by the manufacturer or fabricator shall remain as is unless paint has become marred or damaged during installation, in which case the equipment shall be repainted to its original condition by CONTRACTOR.

3.04 Field Quality Control

A. Requirements of Regulatory Agencies:

- 1. Materials and equipment required for the work and the installation shall conform to all national, state, and local codes, rules, regulations, and ordinances. CONTRACTOR shall secure all permits, inspections, and tests required in connection with his portion of the Project.

B. Tests:

1. After the installation of apparatus and wiring has been completed, all electrical conductors shall be tested by CONTRACTOR to ensure continuity, phasing, proper splicing, freedom from unwanted grounds, and insulation values.
2. A 1,000-volt hand-driven megger shall be used on all 600 volt insulated service conductors and a 500 volt hand-driven megger may be used on all lower voltage insulated service conductors. Conductors shall be isolated from other equipment during test and each cable shall be tested until reaching a constant value for 15 seconds.
3. Megger and high potential tests of multiple conductor cables shall be applied between one conductor and ground with all other conductors connected to the same ground. Each conductor shall be tested in like manner.
4. Wiring not measuring up to minimum ICEA field testing standards shall be replaced.
5. Minimum acceptable reading is 100 megohms for 600 volt insulated service conductors and 1.0 megohms for lower voltage insulated services such as instrumentation cables.
6. Tests shall be made with lightning arrestors removed and disconnections made at points of final termination.
7. Motor rotation shall be checked with the motor disconnected mechanically from equipment to be driven, to prevent damage to the equipment. Motor rotation shall be as directed by the equipment manufacturer and shall be checked for accuracy in cooperation with the manufacturer.
8. Do not test the equipment unless it is sufficiently lubricated.

a. Tests on Grounding

- (1) Inspect ground conductors and connections for conformance with design specifications and for satisfactory workmanship.

Test resistance to earth of each ground rod and each ground grid.

- (2) Test ground paths for equipment and structural steel grounding.

- b. Maintain each ground rod isolated from the associated ground grid for tests on individual rods for resistance to earth.
- c. Include associated ground rods and interconnecting wiring in tests on each grid system for resistance to earth.
- d. Include ground bus on equipment, grid connection, and associated intermediate copper ground conductors in tests on ground paths for electrical equipment.

- e. Include structural steel connection, grid connection and intermediate conductor in tests on ground paths for structural steel.
 - f. Test each ground rod for resistance to earth by a standard method. Use a Biddle ground tester or the method of using two auxiliary ground rods as described in IEEE Standard No. 550, paragraph 3.42. The IEEE method requires the use of AC test current. Place auxiliary test rods sufficiently far away from the rod under test so that the regions in which their resistance is localized do not overlap. Calculate ground resistance from the readings taken. Maximum acceptable resistance to earth at each ground rod: 25 ohms.
 - g. If the resistance is found to be higher than 25 ohms, drive additional rods with a minimum separation of 10 feet and connect in parallel with the rod under test until 25 ohms or less is obtained, or increase the length of the rod under test until 25 ohms maximum is obtained.
 - h. Test each isolated ground grid as specified for individual ground rods, except the maximum acceptable resistance to earth is five ohms. In tests on total ground systems, the maximum acceptable resistance to earth is two ohms.
 - i. Test ground paths for electrical equipment and structural steel for continuity by applying a low voltage DC source of current, capable of furnishing up to 100 amperes. The ground path for electrical equipment using structural steel must conduct 100 amperes. Resistance as calculated from the current and voltage must not exceed 0.010 ohms.
 - j. Grounding materials and connections must pass all inspections and must meet all specified maximum and minimum values.
 - k. Make complete records of all tests. Include resistance values obtained, calculations of same, and methods of test and calculation.
- 9. Notice of tests to be performed shall be sent to ENGINEER and OWNER before tests are made.
 - 10. Duplicate certified records of all insulation tests shall be furnished to ENGINEER.

3.05 Adjustment and Cleaning

A. Adjustments:

- 1. CONTRACTOR shall be responsible for making any equipment and instrument adjustments necessary to provide a complete and safe working system under normal operating conditions.
 - a. Equipment to be adjusted shall include, but not limited to, ground fault circuit interrupters, circuit breaker trip settings, motor starter overload settings, thermostats, pressure switches, level switches, limit switches, control instruments, etc.

- b. CONTRACTOR shall provide a coordination study of the electrical system.

B. Manufacturer's Services:

- 1. Services of a factory trained, qualified service representative of the equipment manufacturer shall be provided by CONTRACTOR to inspect the complete equipment installation to ensure that it is installed in accordance with the manufacturer's recommendations, make all adjustments necessary to place the system in trouble-free operation, and instruct the operating personnel in the proper care and operation of the equipment furnished. This will be required for the main switch gear/motor control center, main control panel including all instrumentation and any other major equipment.

C. Cleaning and Finishing:

- 1. Before turning the systems over to OWNER, clean all fixtures, equipment, exposed metal surfaces, and leave all in clean condition at the end of the Work as specified elsewhere in the Contract Documents.

D. Final Inspection:

- 1. Upon completion of the Work, CONTRACTOR shall conduct a complete inspection of all items of Work and make whatever corrections and adjustments are deemed necessary to a well functioning system that will meet with the satisfaction of ENGINEER and OWNER.

End of Section

Section 26 0526 Grounding and Bonding

Part 1 General

1.01 Section Includes

- A. Grounding electrodes and conductors.
- B. Equipment grounding conductors.
- C. Bonding.

1.02 Related Sections

- A. Section 26 0500: Common Work Results for Electrical
- B. Section 26 0510: Basic Electrical Materials and Methods
- C. Section 26 0705: Electrical Test Certificates

1.03 References

- A. ANSI/NFPA 70 - National Electrical Code.

1.04 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.

1.05 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.

1.06 Submittals

- A. Shop drawings shall be submitted in accordance with Section 01 3300, Submittal Procedures.
- 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.

1.07 Project Record Documents

- A. Submit under provisions of Section 01 7700, Closeout Procedures.

- B. Accurately record actual locations of grounding electrodes.

1.08 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

2.01 Rod Electrodes

- A. Ground rods shall be ¾-inch 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.

2.02 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.

2.03 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.

2.04 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

3.01 Examination

- A. Verify that final backfill, and compaction has been completed before driving rod electrodes.

3.02 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.

3.03 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

Section 26 0529

Hangers and Supports for Electrical Systems

Part 1 General

1.01 Section Includes

- A. Conduit and equipment supports.
- B. Anchors and fasteners.

1.02 References

- A. NECA - National Electrical Contractors Association.
- B. ANSI/NFPA 70 - National Electrical Code.

1.03 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- 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.

1.04 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

2.01 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. 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 0.040-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

3.01 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 ENGINEER before using powder-actuated anchors.
- F. Obtain permission from 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. 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 0.040-inch (40 mil) thickness as specified under Section 26 0533.23, Surface Raceways for Electrical Systems. Where factory PVC coating is not available, factory or field coating with a corrosion resistant, epoxy paint shall be provided.

End of Section

Section 26 0533.13

Underground Conduit System

Part 1 General

1.01 Section Includes

- A. Direct buried conduit.

1.02 Related Sections

- A. Section 26 0500: Common Work Results for Electrical
- B. Section 26 0510: Basic Electrical Materials and Methods

1.03 References

- A. ANSI C80.1 – Rigid Steel Conduit, Zinc-Coated.
- B. UL 6 Standard for Rigid Metal Conduit.
- C. ANSI/ASTM A153 – Zinc Coating (Hot Dip) on Iron and Steel Hardware.
- D. ANSI/ASTM A569 – Steel, Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled, Commercial Quality.
- E. ANSI/IEEE C2 – National Electrical Safety Code.
- F. ANSI/NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
- G. ANSI/NFPA 70 – National Electrical Code.
- H. ASTM A48 – Gray Iron Castings.
- I. ASTM A123 – Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips.
- J. NEMA TC 2 – Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
- K. NEMA TC 3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing.
- L. NEMA TC 6 – PVC and ABS Plastic Utilities Duct for Underground Installation.
- M. NEMA TC 7 – Smooth Wall Coilable Polyethylene Electrical Plastic Duct.
- N. NEMA TC 8 – Extra-Strength PVC Plastic Utilities Duct for Underground Installation.
- O. NEMA TC 9 – Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation.
- P. NEMA TC 10 – PVC and ABS Plastic Communications Duct and Fittings for Underground Installation.
- Q. NEMA TC 14 – Filament-Wound Reinforced Thermosetting Resin Conduit and Fittings.

1.04 Submittals

- A. Shop drawings shall be submitted in accordance with Section 01 3300, Submittal Procedures.
- B. Shop Drawings: Indicate dimensions, reinforcement, size and locations of openings, and accessory locations for precast manholes and handholes.
- C. Shop Drawings: Indicate dimensions, reinforcement, size, and routings of all underground ducts and duct banks.
- D. Product Data: Provide for metallic conduit; non-metallic duct, conduit, and duct fittings; manhole and handhole accessories, frames, and covers.
- E. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation.

1.05 Project Record Documents

- A. Shop drawings shall be submitted in accordance with Section 01 3300, Submittal Procedures and Section 01 7700, Closeout Procedures.
- B. Accurately record actual locations of exact routing of all duct banks and underground conduit runs.
- C. Accurately record actual locations of each manhole and handhole.

1.06 Regulatory Requirements

- A. Conform to requirements of ANSI/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.

1.07 Delivery, Storage, and Handling

- A. Deliver, store, protect, and handle Products to site under provisions of Section 01 6000, Product Requirements.
- B. Accept conduit on site. Inspect for damage.
- C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.08 Project Conditions

- A. Verify that field measurements are as shown on the Contract Drawings.
- B. Verify routing and termination locations of underground conduits prior to excavation for rough-in.

Part 2 Products

2.01 Rigid Steel Conduit

- A. Manufacturers: As specified under Section 26 0533.
- B. Rigid Steel Conduit: ANSI C80.1, UL6.
- C. Fittings: ANSI/NEMA FB 1; UL Standard 514B; steel.

2.02 Non-Metallic Conduit

- A. Manufacturers:
 - 1. Carlon
 - 2. JM Eagle
 - 3. Osburn Associates, Inc.
 - 4. Scepter
 - 5. Cantex
- B. Description: NEMA TC 2; Schedule 40 PVC.
- C. Fittings and Conduit Bodies: NEMA TC 3. All fittings and adapters shall be as supplied by the conduit manufacturer.

2.03 Non-Metallic, PVC Duct

- A. Manufacturers:
 - 1. Carlon
 - 2. JM Eagle
 - 3. Robintech
 - 4. Osburn Associates, Inc.
- B. Plastic Utilities Duct: NEMA TC 8; PVC, Type EB or DB.
- C. Plastic Utility Duct Fittings: NEMA TC 9.
- D. Plastic Communications Duct and Fittings: NEMA TC 10, Type EB or DB.
- E. All fittings and adapters shall be as supplied by the duct manufacturer.

2.04 Non-Metallic, FRP Duct

- A. Manufacturers:
 - 1. FRE Composites, Inc.
 - 2. A. O. Smith/Inland
 - 3. Champion Fiberglass
- B. Conduit and Fittings: NEMA TC 14; Type SW or HW. All fittings and adapters shall be as supplied by the duct manufacturer.
- C. Joining Method: Tapered bell and spigot joints.

2.05 High Density Polyethylene (HDPE) Conduit

- A. Manufacturers:
 - 1. Dura-line
 - 2. Carlon
- B. All fittings and adapters shall be as supplied by the duct manufacturer.

Part 3 Execution

3.01 Examination

- A. Verify that excavation, base material installation, and compaction is completed.

3.02 Direct Buried Conduit Installation

- A. Underground conduits for direct burial shall be rigid steel conduit or non-metallic conduit.
- B. Install rigid steel conduit according to NECA 101-2006.
- C. Plastic fittings shall be of the type recommended for the type of conduit used. All conduits shall be coupled together to make a water-tight connection.
- D. Install non-metallic conduit in accordance with manufacturer's instructions.
- E. Join non-metallic 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.
- F. All direct buried conduits shall be installed 30" minimum below grade (unless otherwise shown on Plans) and shall slope (minimum 3" per 100 feet) to handholes, manholes, cable vaults, or other structures.
- G. All changes in conduit elevation such as ells, stubs, bends, etc., shall be galvanized rigid steel. All conduit risers above grade shall be rigid steel. Conduits shall be rigid steel within 10'-0" of all structures. All conduits under buildings shall be rigid steel.
- H. Provide suitable fish line in each spare or empty duct, except sleeves and nipples.
- I. Excavate and backfill trenches in accordance with other Sections of the Specifications, or in accordance with the Contract Drawings. Install warning tape above all duct runs, as indicated on the Contract Drawings.

End of Section

Section 26 0533.16

Boxes for Electrical Systems

Part 1 General

1.01 Section Includes

- A. Wall and ceiling outlet boxes.
- B. Pull and junction boxes.
- C. Wireways.

1.02 Related Sections

- A. Section 26 0500: Common Work Results for Electrical Systems
- B. Section 26 0510: Basic Electrical Materials and Methods
- C. Section 26 0529: Hangers and Supports for Electrical Systems
- D. Section 26 0553.13: Conduit for Electrical Systems
- E. Section 26 0533.23: Surface Raceways for Electrical Systems
- F. Section 26 2716: Electrical Cabinets and Enclosures
- G. Section 26 2726: Wiring Devices

1.03 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.

1.04 Submittals

- A. Shop drawings shall be submitted in accordance with Section 01 3300, Submittal Procedures.
- 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.

1.05 Submittals for Closeout

- A. Shop drawings shall be submitted in accordance with Section 01 3300, Submittal Procedures, and Section 01 7700, Closeout Procedures.
- B. Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.06 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. Boxes shall be sized per Article 314 of the National Electrical Code as a minimum.

Part 2 Products

2.01 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 26 2716.
- E. Covers for boxes containing wiring devices shall be as specified in Section 26 2716.
- 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.

2.02 Pull and Junction Boxes

- A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- B. Hinged Enclosures: As specified in Section 26 2716
- 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 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, 304 stainless steel 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.

2.03 Wireways

- A. Wiring ducts shall be NEMA Type 4X in corrosive locations; or stainless steel, 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.

2.04 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

3.01 Examination

- A. Verify locations of floor boxes and outlets in all work areas prior to rough-in.

3.02 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 26 0553
- 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 26 2716.
- K. Maintain headroom and present neat mechanical appearance.
- L. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in **Section 07270**.
- M. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
- N. Use flush mounting outlet box in finished areas.
- O. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- P. 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.
- Q. Support boxes independently of conduit.
- R. Use gang box where more than one device is mounted together. Do not use sectional box.
- S. Use cast outlet box in exterior locations and wet locations.
- T. Set floor boxes level.
- U. Wall and ceiling mounted pull and junction boxes shall be spaced ½-inch minimum out from the wall or ceiling using corrosion resistant channel: Unistrut; Grinnell "Power-Strut", or other approved corrosion resistant spacers.

- V. Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.
- W. 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.
- X. 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 0.040-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.

3.03 Adjusting

- A. Adjust flush-mounting outlets to make front flush with finished wall material.
- B. Install knockout closures in unused box openings.

3.04 Cleaning

- A. Clean interior of boxes to remove dust, debris, and other material.
- B. Clean exposed surfaces and restore finish.

End of Section

Section 26 0533.23

Surface Raceways for Electrical Systems

Part 1 General

1.01 Section Includes

- A. Metal conduit.
- B. Flexible metal conduit.
- C. Liquidtight flexible metal conduit.
- D. Non-metallic conduit.
- E. Flexible non-metallic conduit.
- F. Fittings and conduit bodies.

1.01 Related Sections

- A. Section 26 0500: Common Work Results for Electrical Systems
- B. Section 26 0510: Basic Electrical Materials and Methods
- C. Section 26 0529: Hangers and Supports for Electrical Systems
- D. Section 26 0526: Grounding and Bonding for Electrical Systems
- E. Section 26 0529: Hangers and Supports for Electrical Systems
- F. Section 26 0533.16: Boxes for Electrical Systems
- G. Section 26 0553: Identification for Electrical Systems
- H. Section 26 0700: Wire and Cable
- I. Section 26 0705: Electrical Testing and Equipment

1.02 References

- A. ANSI C80.1 – Rigid Steel Conduit, Zinc Coated.
- B. ANSI/NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
- C. ANSI/NFPA 70 – National Electrical Code.
- D. NECA 101-2013, Steel Conduits (Rigid, IMC, EMT).
- E. NECA 111-2003, Standard for Installing Non-metallic Raceways.
- F. NEMA RN 1 – Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
- G. NEMA TC 2 – Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
- H. NEMA TC 3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing.
- I. UL 6 Standard for Rigid Metal Conduit.

1.03 Submittals

- A. Submit in accordance with Section 01 3300, Submittal Procedures.
- B. Shop Drawings: 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.

1.04 Delivery, Storage, And Handling

- A. Deliver, store, protect, and handle Products to site under provisions of Section 01 6000, Product Requirements.
- 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.

1.05 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

2.01 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 aluminum unless indicated otherwise.
- B. No threadless couplings or running threads will be permitted on rigid conduits.
- C. No conduit smaller than $\frac{3}{4}$ -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, 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.

2.02 Rigid Metal Conduit

- A. Rigid aluminum conduits shall be manufactured of 6063 alloy, temper T-1, and especially selected with reference to uniformity of thickness and free from defects.
- B. Manufacturers:
 - 1. V.A.W. of America, Inc.
 - 2. Alcoa
 - 3. Or Approved Equal
- C. Rigid Aluminum Conduit: ANSI C80.5, UL 6.

2.03 PVC Coated Metal Conduit and Fittings

- A. Manufacturers:
 - 1. Thomas & Betts Ocal Blue
 - 2. Robroy Industries Plasti-Bond Red H₂O^T
- 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 0.040-inch (40 mil) thickness minimum on the exterior and a urethane coating of 0.002-inch (2 mil) thickness nominal or a phenolic coating of 0.003-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.

2.04 Flexible Metal Conduit

- A. Manufacturers:
 - 1. AFC
 - 2. Southwire - Alflex

- B. Description: Interlocked steel construction.
- C. Fittings: ANSI/NEMA FB 1.
- D. Flexible metallic conduit shall be 3/4-inch nominal trade size (minimum) flexible steel conduit tubing, hot-dipped galvanized, meeting Underwriters' Laboratories Standard for flexible steel conduit (UL 1).

2.05 Liquidtight Flexible Metal Conduit

- A. Manufacturers:
 - 1. Anaconda "Sealtite" Type LA
 - 2. Electriflex
 - 3. AFC
 - 4. Thomas & Betts Corp.
- 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 liquid tight 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.

2.06 Non-Metallic, PVC Conduit

- A. Manufacturers:
 - 1. Thomas & Betts – Carlon
 - 2. JM Eagle
 - 3. Osburn Associates, Inc.
 - 4. IPEX - Scepter
 - 5. Cantex
- 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.

2.07 Non-Metallic, FRP Conduit and Fittings

- A. Manufacturers:
 - 1. FRE Composites, Inc.
 - 2. A.O. Smith/Inland
 - 3. Champion Fiberglass

- B. Conduit and fittings: NEMA TC 14; Type SW or HW. All fittings and adapters shall be as supplied by the duct manufacturer.
- C. Joining method: Tapered bell and spigot joints.

2.08 Liquidtight Flexible Non-Metallic Conduit

- A. Manufacturers:
 - 1. Anaconda "Sealtite" Type CNP
 - 2. Electriflex Liguatite Type LNMP
 - 3. AFC Type LFNC-A
 - 4. Thomas & Betts Corp.
- B. Description: Layered Type A construction with PVC jacket.
- C. Fittings: Non-metallic with UL marking "FNMC-A" or "LFNC-A".
- D. Liquidtight flexible non-metallic conduit shall consist of a water or oil resistant and flame-retardant material. It shall be constructed of a seamless liner and cover, bonded together with one or more layers of flexible, braided, reinforcing cords.

2.09 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 Waterguard 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

3.01 Installation of Raceways

- A. Install conduit in accordance with NECA 101-2013, Aluminum 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 26 0553, Identification for Electrical Systems.
- 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 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 26 0529, Hangers and Supports for Electrical Systems.
- 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. 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 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 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 feet 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 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 26 0526.

- 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. Raceway systems, in general, shall consist of Rigid Metal Conduit and fittings or Non-metallic, FRP Conduit and fittings.
- NN. 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.
- OO. To guarantee proper installation procedures and insure the validation of the manufacturer's warranty, 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 CONTRACTOR. 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.
- PP. 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 0.040-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.
- QQ. Flexible conduit may be used only where rigid conduit is impracticable or where indicated on the Drawings.
- RR. Liquidtight, PVC coated, flexible metal conduit and associated fittings shall be installed as follows:
1. All sections of flexible conduit larger than 1-1/4 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.
- SS. 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 inches of flexible, liquidtight, metallic conduit.
- TT. 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.
- UU. Flexible metallic conduit may be used for final connections to lay-in fluorescent lighting fixtures.
- VV. Plastic (PVC) conduit may be used only where indicated on the Drawings.
- WW. Install non-metallic conduit in accordance with manufacturer's instructions.
- XX. 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. 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 26 0553

Electrical identification

Part 1 General

1.01 Section Includes

- A. Nameplates and labels.
- B. Wire and cable markers.
- C. Conduit markers.

1.02 Related Sections

- A. Section 09 9000: Painting and Coating

1.03 References

- A. ANSI/NFPA 70 - National Electrical Code.

1.04 Submittals

- A. Shop drawings shall be submitted in accordance with Section 01 3300, Submittal Procedures.
- B. Product Data: Provide catalog data for nameplates, labels, signs, diagrams, and markers.
- 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 and installation of Product.

1.05 Regulatory Requirements

- A. Conform to requirements of ANSI/NFPA 70.

Part 2 Products

2.01 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: _____

- D. 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.

2.02 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

3.01 Preparation

- C. Degrease and clean surfaces to receive adhesive nameplates and labels.

3.02 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 control center, 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:
- a. First Line - Process description, equipment served, or area served (if applicable).

- b. Second Line - Equipment or device description.
 - c. Third Line - Equipment or device designation number and power source circuit number.
 - d. Abbreviations shall be used only where full wording will not fit. See the Drawings for nameplate details.
- 2. 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.
 - 3. The entire raceway system for intrinsically safe circuits shall be labeled "Intrinsic Safety Wiring" per National Electrical Code Article 504.80(B).
 - 4. All pull boxes shall be marked with the type of system within them, i.e.: 480V power, alarm, 120V control, etc.
 - 5. All wires and cables within control panels, motor starters, motor control centers, terminal boxes, etc. shall be tagged at each termination.
 - 6. 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.
 - 7. 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.
 - 8. 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 26 0705, Electrical Testing and Equipment.
 - 9. Label or otherwise clearly identify all panelboard branch circuit breakers feeding emergency lighting and exit fixtures as required by National Electrical Code Article 700.12(E).

End of Section

Section 26 0700 Wire and Cable

Part 1 General

1.01 Section Includes

- A. Building wire.
- B. Underground feeder and branch circuit wire.
- C. VFD load wire.
- D. Service entrance cable.
- E. Instrumentation cable.
- F. Communications cables.
- G. Wiring connectors and connections.

1.02 Related Sections

- A. Section 26 0500
- B. Section 26 0529
- C. Section 26 0533
- D. Section 26 0533.16
- E. Section 26 0553

1.03 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.

1.04 Submittals

- A. Shop drawings shall be submitted in accordance with Section 01 3300, Submittal Procedures.
- 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.

1.05 Project Conditions

- A. Verify that field measurements are as shown on the Contract 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.

1.06 Coordination

- A. Coordinate Work under provisions of Section 01 3119, Project Meetings.
- B. Determine required separation between cable and other work.
- C. Determine cable routing to avoid interference with other work.

Part 2 Products**2.01 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.

2.02 Manufacturers – Building Wire

- A. General Cable
- B. Southwire Corporation

2.03 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.

2.04 Manufacturers – Underground Feeder and Branch-Circuit Wire

- A. General Cable
- B. Southwire Corporation

2.05 underground feeder and branch-circuit wire

- A. Description: Single conductor, ANSI/NFPA 70, Type USE-2.
- B. Conductor: Annealed 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: Type RHW-2.

2.06 Manufacturers-VFD Load Wire

- A. Southwire Corp.
- B. Belden
- C. General Cable
- D. Okonite Okoguard-Okolon
- E. Prysmian Cables & Systems

2.07 VFD Load Wire

- A. Description: Single 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.

2.08 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.

2.09 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.

2.10 Manufacturers – Communications Cable

- A. RS-232/422, RS-485/DH-485, Ethernet (Category 5), 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.

2.11 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.

2.12 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. Watertight Cord Grip Fittings:

1. Crouse-Hinds CGB-SG Series
2. Appleton Electric Co.
3. Thomas & Betts

N. Cable or Cord Strain Relief:

1. Hubbell-Kellems
2. Daniel Woodhead Co.

O. Cable Pulling Lubricant:

1. American Polywater “Dyna-Blue”
2. Ideal “Aqua Gel”
3. Minerallac “Golden Glide”
4. 3M™ Company “GEL”

2.13 Wiring Connectors and Associated Materials

A. All wiring connectors shall be 75°C rated and suitable for use on copper conductors.

B. 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.

C. 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.

D. 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 Part 2 Execution

3.01 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.

3.02 Preparation

- A. Completely and thoroughly swab raceway before installing wire.

3.03 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 or metal sheathed or metal clad cable, where indicated.
 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 Type XHHW-2 insulation, underground feeder and branch circuit wire.
 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.

3.04 Color Coding

- A. 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.
- B. The installation of intrinsically safe circuits shall meet all requirements of the NEC.
- C. 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.

3.05 Installation

- A. The installation of communication cables shall meet the requirements of NECA/BICSI 568-2001, Telecommunications.
- B. The installation of fiber optic cables shall be per NECA/FOA 301-1997, Fiber Optic Cables, requirements.
- C. All wiring shall be run in rigid metal raceway systems, underground conduit systems, or non-metallic FRP conduit systems, unless noted otherwise.
- D. Install products in accordance with manufacturer's instructions.
- E. The minimum size of conductors shall be No. 12 AWG, unless specifically approved and/or shown otherwise on the Drawings.
- F. Use stranded conductors for control circuits, No. 14 AWG minimum, unless shown otherwise on the Drawings.
- G. Multi-conductor underground feeder, branch-circuit, and control cable shall meet the requirements of Article 340 of the National Electrical Code.
- H. Use No. 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 60 feet.
- I. Use No. 8 AWG conductors for 20 ampere, 120 volt branch circuits longer than 100 feet.
- J. Use No. 6 AWG conductors for 20 ampere, 120 volt branch circuits longer than 170 feet.
- K. Use No. 4 AWG conductors for 20 ampere, 120 volt branch circuits longer than 270 feet.
- L. Use No. 3 AWG conductors for 20 ampere, 120 volt branch circuits longer than 420 feet.
- M. 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.
- N. Pull all conductors into raceway at same time. Cable pulling tensions shall not exceed manufacturer's recommended values.
- O. 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.
- P. Use suitable cable fittings and connectors.
- Q. Neatly train and lace wiring inside boxes, equipment, and panelboards. Wires and cables shall be bundled and laced as specified in Section 26 0533.23.
- R. 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.
- S. Clean conductor surfaces before installing lugs and connectors.

- T. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- U. 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.
- V. Spade or fork tongue lugs shall not be used, except where approved by the Owner.
- W. Conductor terminations and tap splices within lighting fixture pole/transformer bases shall be suitable for wet or damp locations.
- X. 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.
- Y. Splices and tap connections shall be made in junction boxes only; conduit type fittings shall not be used as junction boxes.
- Z. Wires and cables shall be installed in raceways, as indicated on the Drawings or required, and shall provide a complete and operating system.
- AA. All wires and cables shall be tagged as specified in Section 26 0553.
- BB. Motor control center feeder circuits and distribution panelboard branch circuits shall each be run in individual raceways from source to motor or other load.
- CC. 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.
- DD. Vertical lengths of exposed cable or cord runs over ten feet long shall be supported with a strain relief.
- EE. 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.
- FF. 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.
- GG. Make conductor length for parallel feeders identical on each phase leg.
- HH. 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.
- II. 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.

- JJ. All secondary wire and cables run exposed through manholes, handholes, and cable vaults shall be fireproofed, where exposed. Fireproofing of wire and cables shall be accomplished with half lapped taping using fireproofing tape made of heat resistant organic fabric coated on one side with a flame-retardant elastomer. The fireproofing tape shall be held in place by spiral wrapping at recommended intervals using woven fiberglass tape.

3.06 Interface with Other Products

- A. Identify wire and cable under provisions of Section 26 0553, Identification of Electrical Systems.
- B. Identify each conductor with its circuit number or other designation indicated on Drawings.

3.07 Field Quality Control

- A. Perform field inspection and testing under provisions of Sections 01 4500, Quality Control and 26 0705, Electrical Testing and Equipment.
- 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 OWNER.

End of Section

Section 26 0705

Electrical Testing and Equipment

Part 1 General

1.01 Section Includes

- A. Division 26 testing requirements.
- B. Test equipment requirements.
- C. Sample forms.

1.02 Related Sections

- A. Section 01 4500: Quality Control
- B. Section 26 0500: Common Work Results for Electrical
- C. Section 26 0510: Basic Electrical Materials and Methods
- D. Section 26 0800: Commissioning of Electrical Systems

1.03 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.

1.04 Submittals

- A. Submit on Products under provisions of Section 01 3300, Submittal Procedures.
- 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.

1.05 Project Record Documents

- A. Submit test results under provisions of Section 01 7700.

1.06 Operation and Maintenance Data

- A. Submit under provisions of Section 01 7900.
- 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).

1.07 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.

1.08 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.

1.09 Delivery, Storage, And Handling

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 6000.
- B. Accept products on site in factory containers. Inspect for damage. Turn over to OWNER immediately.

Part 2 Part 2 Products

2.01 Materials and Equipment

- A. The work shall include, but is not limited to, the following major items:
 - 1. Programming.
 - 2. Testing, Start-up, Demonstration, and Training for all electrical, instrumentation and controls equipment and/or systems furnished and installed as a part of Division 26.

Part 3 Execution

3.01 Testing

- A. 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.

- C. All tests shall be witnessed by OWNER and four (4) copies of all field tests, as specified herein and in other Sections, shall be submitted to OWNER. Twenty-four (24) hours (minimum) written notice shall be given OWNER prior to performing the tests. Such tests shall be scheduled at a time agreed upon by OWNER and 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. Ground fault detection systems shall be tested in accordance with the NEC, UL, and manufacturer's recommendations.
 - 5. Power Cable Tests shall be performed by a NETA full member testing company, supervised by a certified NETA testing leader, and made as follows:
 - a. All new 480-volt feeder and branch circuit wires and cables between transformers and all motor control center and distribution panelboard conductors 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.
 - 6. 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 (480-volt cables only).
 - 7. In order to be acceptable, the cable must withstand the specified high voltage without breakdown or have satisfactory megger readings.
- E. 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 CONTRACTOR and re-tested at no additional cost to OWNER.

3.02 Contractor's Assistance

- A. Testing of Package equipment, as described in Section 16010, shall be as required in other Sections of this Specification.

- B. Provide the services of an electrician to assist either 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. CONTRACTOR shall make equipment manufacturers' service representatives available as required to assist in testing or putting equipment into operation.

3.03 Demonstration

- A. After acceptance of the test equipment, OWNER's operators shall be provided with one day (in two 1/2-day sessions) of onsite training in the use and maintenance of each piece of the equipment. Training shall cover the operation of the test equipment, preventative maintenance of all equipment, and trouble-shooting and repair/replacement procedures.

End of Section

Section 26 0705.10
Electrical Test Certificates

See following pages for individual Certifications

Cable Test Certificate

1.0 TECHNICIAN INFORMATION

Company Name: _____
 Address: _____

Contact Person: _____
 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 conform to manufacturer and Contract Specification requirements, unless otherwise noted.

Technician Signature: _____ Date: _____

6.0 ENGINEER REVIEW

Test Witnessed: ☐ Yes ☐ No Reviewer Signature: _____ Date: _____

Instrument Calibration Certificate

1.0 INSTRUMENT IDENTIFICATION

Tag Number _____
 Instrument Name _____
 DCS Point Reference _____
 Manufacturer _____
 Model Number _____
 Part Number _____
 Cal. Range _____
 Serial Number _____

2.0 CALIBRATION / TEST EQUIPMENT IDENTIFICATION

Description _____
 Manufacturer _____
 Model Number _____
 Part Number _____
 Serial Number _____
 Calibration Date _____
 Accuracy _____

3.0 INSTRUMENT INSTALLATION

Installed per manufacturers instructions: _____ Yes _____ No
 Installed per Contract Specifications: _____ Yes _____ No
 Discrepancy Description _____
 Wiring Continuity from Instrument to Instrument: _____ N/A _____ OK
 Wiring Continuity from Instrument to RIO Cabinet: _____ N/A _____ OK

4.0 INSTRUMENT CALIBRATION – ANALOG / DIGITAL

<u>Level</u>	<u>Input Units</u>	<u>Value at Indicator</u>	<u>Value at DCS/PLC</u>
0 %	_____	_____	_____
10 %	_____	_____	_____
50 %	_____	_____	_____
80 %	_____	_____	_____
100 %	_____	_____	_____

	<u>Setting</u>	<u>Deadband</u>	<u>Activation at Device</u>	<u>Activation at DCS</u>
Point 1	_____	_____	_____	_____
Point 2	_____	_____	_____	_____
Point 3	_____	_____	_____	_____

5.0 INSTRUMENT ADJUSTMENT SEALED

Adjustment Device Sealed With Colored Lacquer _____

6.0 CERTIFICATION

I certify that the above information is correct and that the instrument installation conforms to manufacturer and Contract Specifications, unless otherwise noted.

Technician Signature _____ Date: _____

7.0 ENGINEER REVIEW

Calibration Witnessed: ☐ Yes ☐ No

Reviewer Signature _____ Date: _____

Device Settings Certificate For Motor Protection Relay (MPR)

1.0 TECHNICIAN INFORMATION

Company Name: _____

Contact Person: _____

Address: _____

Phone No.: _____

2.0 EQUIPMENT IDENTIFICATION

Starter or Panel Designation: _____

3.0 DEVICE SETTINGS

Attach Manufacturer's form(s), with settings filled in, whenever available.

MPR SETTINGS			
Device ID		Jam Trip Run Delay in Seconds	
Manufacturer		Underload Trip Level in % of FLA	
Model No.		Underload Trip and Alarm Start Delay in Seconds	
Full Load Amp Rating		Underload Trip Run Delay in Seconds	
Locked Rotor Current in % of FLA		Phase Unbalance Trip Level	
Maximum Allowable Stall Time in Seconds		Phase Unbalance Trip and Alarm Start Delay in Seconds	
Ultimate Trip Current in % of FLA		Phase Unbalance Trip Run Delay in Seconds	
Phase CT Ratio		Ground Fault Alarm Level in % of Ground CT Ratio	
Ground CT Ratio		I ² T Alarm Level in % of Full I ² T Trip Capacity	
50 or 60 Hertz Line Frequency		Jam Alarm Level in % of FLA	
Reversing or Non-reversing Starter		Jam Alarm Run Delay in Seconds	
RTD Temp in Degrees F or Degrees C		Underload Alarm Level in % of FLA	
Winding Temperature Trip		Underload Alarm Run Delay in Seconds	
Winding Temperature Alarm		Phase Unbalance Alarm Level	
Motor Bearing Temperature Trip		Phase Unbalance Alarm Run Delay in Seconds	
Motor Bearing Temperature Alarm		Starts Per Time Allowed	
Load Bearing Temperature Trip		Time Allowed for Starts Count in Minutes	
Load Bearing Temperature Alarm		Time Between Starts in Minutes	
Auxiliary Trip		Number of Cold Starts Allowed	
Auxiliary Alarm		Motor Start Transition Current Level in % of FLA	
Alarm on RTD Failure Diagnostic		Motor Start Transition Time in Seconds	
Ground Fault Trip Level in % of Ground CT Ratio		Transition on Time, Current, Time or Current, or Time and Current	
Ground Fault Start Delay in Cycles		Incomplete Sequence Report Back Time in Seconds	
Ground Fault Run Delay in Cycles		Incomplete Seq. Start Timer Initiated by	

MPR SETTINGS... <i>continued</i>			
Instantaneous Overcurrent in % of FLA		Long Acceleration Time in Seconds	
Instantaneous Overcurrent Start Delay in Cycles		Zero Speed Switch ON or OFF	
Jam Trip Level in % of FLA		Anti-Backspin Delay Time in Minutes	
Jam Trip and Alarm Start Delay in Seconds			

4.0 CERTIFICATION

I certify that the above information is correct and that the instrument installation conforms to manufacturer and Contract Specifications, unless otherwise noted.

Technician Signature _____ Date: _____

5.0 ENGINEER REVIEW

Calibration Witnessed: ☐ Yes ☐ No

Reviewer Signature _____ Date: _____

Device Settings Certificate for Circuit Breakers

1.0 TECHNICIAN INFORMATION

Company Name: _____

Contact Person: _____

Address: _____

Phone No.: _____

2.0 EQUIPMENT IDENTIFICATION

Panel or Switchgear Designation: _____

3.0 DEVICE SETTINGS

Attach Manufacturer's form(s), with settings filled in, whenever available.

BREAKER SETTINGS									
Breaker ID:									
Device Manufacturer									
Device Model No.									
Bus Number									
Curve Shape									
Inv. TM. PU.									
Inv. TM. MULT.									
Short TM. Delay									
Inst. PU.									
Discrim.									
High Load TM.									
Frequency									
C.T. Ratio									
Ground Settings									

4.0 CERTIFICATION

I certify that the above information is correct and that the instrument installation conforms to manufacturer and Contract Specifications, unless otherwise noted.

Technician Signature _____ Date: _____

5.0 ENGINEER REVIEW

Calibration Witnessed: ☐ Yes ☐ No

Reviewer Signature _____ Date: _____

Device Settings Certificate For Variable Frequency Controller

1.0 TECHNICIAN INFORMATION

Company Name: _____

Contact Person: _____

Address: _____

Phone No.: _____

2.0 EQUIPMENT IDENTIFICATION

VFD Designation: _____

3.0 DEVICE SETTINGS

Attach Manufacturer's form(s), with settings filled in, whenever available.

SETTINGS					
Device ID:	VFD #	VFD #	VFD #	VFD #	VFD #
Manufacturer					
Model No.					
Accel Time (seconds)					
Decel Time (seconds)					
Minimum Speed (Hz)					
Maximum Speed (Hz)					
Current Limit (%)					
Manual Torque Boost (%)					
V/Hz Base Speed (Hz)					
RPM at Base Speed					
Output Relay Configured to					
Carrier Frequency (kHz)					
Remote Reference Gain (%)					
Remote Reference Offset (%)					
Electronic Thermal Overload (%)					
Electronic Thermal Overload Trip (on/off)					
Coast Stop Feature (on/off)					
Reverse (on/off)					
RPM Setpoint Feature (on/off)					
Power-Up Start Feature (on/off)					
Password Lockout Feature (on/off)					
Avoidance Frequency (Hz)					
Avoidance Bandwidth (Hz)					
Multi-Speed Preset 1 (Hz)					
Multi-Speed Preset 2 (Hz)					
Multi-Speed Preset 3 (Hz)					
Auto-Restart Number of Attempts					
Auto-Restart Retry Wait Time (seconds)					
Analog Output Configured to					

4.0 CERTIFICATION

I certify that the above information is correct and that the instrument installation conforms to manufacturer and Contract Specifications, unless otherwise noted.

Technician Signature _____ Date: _____

5.0 ENGINEER REVIEW

Calibration Witnessed: ☐ Yes ☐ No

Reviewer Signature _____ Date: _____

Section 26 0705.10
Electrical Test Certificates

See following pages for individual Certifications

Cable Test Certificate

1.0 TECHNICIAN INFORMATION

Company Name: _____
 Address: _____

Contact Person: _____
 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 conform to manufacturer and Contract Specification requirements, unless otherwise noted.

Technician Signature: _____ Date: _____

6.0 ENGINEER REVIEW

Test Witnessed: ☐ Yes ☐ No Reviewer Signature: _____ Date: _____

Instrument Calibration Certificate

1.0 INSTRUMENT IDENTIFICATION

Tag Number _____
 Instrument Name _____
 DCS Point Reference _____
 Manufacturer _____
 Model Number _____
 Part Number _____
 Cal. Range _____
 Serial Number _____

2.0 CALIBRATION / TEST EQUIPMENT IDENTIFICATION

Description _____
 Manufacturer _____
 Model Number _____
 Part Number _____
 Serial Number _____
 Calibration Date _____
 Accuracy _____

3.0 INSTRUMENT INSTALLATION

Installed per manufacturers instructions: _____ Yes _____ No
 Installed per Contract Specifications: _____ Yes _____ No
 Discrepancy Description _____
 Wiring Continuity from Instrument to Instrument: _____ N/A _____ OK
 Wiring Continuity from Instrument to RIO Cabinet: _____ N/A _____ OK

4.0 INSTRUMENT CALIBRATION – ANALOG / DIGITAL

<u>Level</u>	<u>Input Units</u>	<u>Value at Indicator</u>	<u>Value at DCS/PLC</u>
0 %	_____	_____	_____
10 %	_____	_____	_____
50 %	_____	_____	_____
80 %	_____	_____	_____
100 %	_____	_____	_____

	<u>Setting</u>	<u>Deadband</u>	<u>Activation at Device</u>	<u>Activation at DCS</u>
Point 1	_____	_____	_____	_____
Point 2	_____	_____	_____	_____
Point 3	_____	_____	_____	_____

5.0 INSTRUMENT ADJUSTMENT SEALED

Adjustment Device Sealed With Colored Lacquer _____

6.0 CERTIFICATION

I certify that the above information is correct and that the instrument installation conforms to manufacturer and Contract Specifications, unless otherwise noted.

Technician Signature _____ Date: _____

7.0 ENGINEER REVIEW

Calibration Witnessed: ☐ Yes ☐ No

Reviewer Signature _____ Date: _____

Device Settings Certificate For Motor Protection Relay (MPR)

1.0 TECHNICIAN INFORMATION

Company Name: _____

Contact Person: _____

Address: _____

Phone No.: _____

2.0 EQUIPMENT IDENTIFICATION

Starter or Panel Designation: _____

3.0 DEVICE SETTINGS

Attach Manufacturer's form(s), with settings filled in, whenever available.

MPR SETTINGS			
Device ID		Jam Trip Run Delay in Seconds	
Manufacturer		Underload Trip Level in % of FLA	
Model No.		Underload Trip and Alarm Start Delay in Seconds	
Full Load Amp Rating		Underload Trip Run Delay in Seconds	
Locked Rotor Current in % of FLA		Phase Unbalance Trip Level	
Maximum Allowable Stall Time in Seconds		Phase Unbalance Trip and Alarm Start Delay in Seconds	
Ultimate Trip Current in % of FLA		Phase Unbalance Trip Run Delay in Seconds	
Phase CT Ratio		Ground Fault Alarm Level in % of Ground CT Ratio	
Ground CT Ratio		I ² T Alarm Level in % of Full I ² T Trip Capacity	
50 or 60 Hertz Line Frequency		Jam Alarm Level in % of FLA	
Reversing or Non-reversing Starter		Jam Alarm Run Delay in Seconds	
RTD Temp in Degrees F or Degrees C		Underload Alarm Level in % of FLA	
Winding Temperature Trip		Underload Alarm Run Delay in Seconds	
Winding Temperature Alarm		Phase Unbalance Alarm Level	
Motor Bearing Temperature Trip		Phase Unbalance Alarm Run Delay in Seconds	
Motor Bearing Temperature Alarm		Starts Per Time Allowed	
Load Bearing Temperature Trip		Time Allowed for Starts Count in Minutes	
Load Bearing Temperature Alarm		Time Between Starts in Minutes	
Auxiliary Trip		Number of Cold Starts Allowed	
Auxiliary Alarm		Motor Start Transition Current Level in % of FLA	
Alarm on RTD Failure Diagnostic		Motor Start Transition Time in Seconds	
Ground Fault Trip Level in % of Ground CT Ratio		Transition on Time, Current, Time or Current, or Time and Current	
Ground Fault Start Delay in Cycles		Incomplete Sequence Report Back Time in Seconds	
Ground Fault Run Delay in Cycles		Incomplete Seq. Start Timer Initiated by	

MPR SETTINGS... <i>continued</i>			
Instantaneous Overcurrent in % of FLA		Long Acceleration Time in Seconds	
Instantaneous Overcurrent Start Delay in Cycles		Zero Speed Switch ON or OFF	
Jam Trip Level in % of FLA		Anti-Backspin Delay Time in Minutes	
Jam Trip and Alarm Start Delay in Seconds			

4.0 CERTIFICATION

I certify that the above information is correct and that the instrument installation conforms to manufacturer and Contract Specifications, unless otherwise noted.

Technician Signature _____ Date: _____

5.0 ENGINEER REVIEW

Calibration Witnessed: ☐ Yes ☐ No

Reviewer Signature _____ Date: _____

Device Settings Certificate for Circuit Breakers

1.0 TECHNICIAN INFORMATION

Company Name: _____

Contact Person: _____

Address: _____

Phone No.: _____

2.0 EQUIPMENT IDENTIFICATION

Panel or Switchgear Designation: _____

3.0 DEVICE SETTINGS

Attach Manufacturer's form(s), with settings filled in, whenever available.

BREAKER SETTINGS									
Breaker ID:									
Device Manufacturer									
Device Model No.									
Bus Number									
Curve Shape									
Inv. TM. PU.									
Inv. TM. MULT.									
Short TM. Delay									
Inst. PU.									
Discrim.									
High Load TM.									
Frequency									
C.T. Ratio									
Ground Settings									

4.0 CERTIFICATION

I certify that the above information is correct and that the instrument installation conforms to manufacturer and Contract Specifications, unless otherwise noted.

Technician Signature _____ Date: _____

5.0 ENGINEER REVIEW

Calibration Witnessed: ☐ Yes ☐ No

Reviewer Signature _____ Date: _____

Device Settings Certificate For Variable Frequency Controller

1.0 TECHNICIAN INFORMATION

Company Name: _____

Contact Person: _____

Address: _____

Phone No.: _____

2.0 EQUIPMENT IDENTIFICATION

VFD Designation: _____

3.0 DEVICE SETTINGS

Attach Manufacturer's form(s), with settings filled in, whenever available.

SETTINGS					
Device ID:	VFD #	VFD #	VFD #	VFD #	VFD #
Manufacturer					
Model No.					
Accel Time (seconds)					
Decel Time (seconds)					
Minimum Speed (Hz)					
Maximum Speed (Hz)					
Current Limit (%)					
Manual Torque Boost (%)					
V/Hz Base Speed (Hz)					
RPM at Base Speed					
Output Relay Configured to					
Carrier Frequency (kHz)					
Remote Reference Gain (%)					
Remote Reference Offset (%)					
Electronic Thermal Overload (%)					
Electronic Thermal Overload Trip (on/off)					
Coast Stop Feature (on/off)					
Reverse (on/off)					
RPM Setpoint Feature (on/off)					
Power-Up Start Feature (on/off)					
Password Lockout Feature (on/off)					
Avoidance Frequency (Hz)					
Avoidance Bandwidth (Hz)					
Multi-Speed Preset 1 (Hz)					
Multi-Speed Preset 2 (Hz)					
Multi-Speed Preset 3 (Hz)					
Auto-Restart Number of Attempts					
Auto-Restart Retry Wait Time (seconds)					
Analog Output Configured to					

4.0 CERTIFICATION

I certify that the above information is correct and that the instrument installation conforms to manufacturer and Contract Specifications, unless otherwise noted.

Technician Signature _____ Date: _____

5.0 ENGINEER REVIEW

Calibration Witnessed: ☐ Yes ☐ No

Reviewer Signature _____ Date: _____

Section 26 0710

Demonstration and Training

Part 1 General

1.01 Section Includes

- A. Requirements for Demonstration of equipment and/or systems for OWNER's personnel.
- B. Requirements for Training of OWNER's personnel in the operation and maintenance of the equipment/system.

1.02 Related Sections

- A. Section 01 4500: Quality Control
- B. Section 01 7700: Closeout Procedures
- C. Section 01 7900: Demonstration and Training
- D. Section 26 0500: Common Work Results for Electrical
- E. Section 26 0510: Basic Electrical Materials and Methods
- F. Section 26 0705: Electrical Testing and Equipment
- G. Section 26 0800: Commissioning of Electrical Systems

1.03 References

- A. 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. 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 (Not Used)

Part 3 Execution

3.01 Demonstration of Equipment

- A. Demonstration of equipment and systems, and training of OWNER's personnel in the proper operation and maintenance of the equipment and systems, shall be performed 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. CONTRACTOR shall have fully complied with the requirements of Section 26 0710, Calibration and Start-up of Systems, and shall have submitted reports indicating successful completion of start-up for the equipment/system being started.

2. 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 OWNER's Demonstration and Training, as required per Section 26 0710.
 3. 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. Test equipment, maintenance equipment, tools, or devices, and/or spare parts required to be furnished under Division 26 shall be turned over and stored as required under Sections 01 6000 and 26 0510.
- C. After completing the above items, CONTRACTOR shall schedule OWNER's Demonstration and Training. Seventy-two (72) hours (minimum) written notice shall be given OWNER's Representative prior to performing any Demonstration and/or Training. Such sessions shall be scheduled at a time agreed upon by OWNER and CONTRACTOR. Multiple sessions shall be scheduled to allow attendance by OWNER's Personnel.
 - D. Demonstration shall instruct 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 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 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 OWNER's Representative and four (4) copies of all demonstration and training reports, as specified above and in other Sections, shall be submitted to 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.

3.02 Contractor's Assistance

- A. Demonstration and Training of Package Equipment, as described in Section 26 0710, shall be as required in other Sections of this Specification.
- B. CONTRACTOR shall provide the services of an electrician to assist either 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. CONTRACTOR shall make equipment manufacturers' service representatives available as required to assist in demonstrating equipment operation.

3.03 Cleanup

- A. Cleanup shall occur as required under Section 01 7700, and as specified under Section 26 0710.

3.04 Acceptance

- A. Acceptance shall occur after all the above requirements have been satisfied, and as per Section 01 7700, Closeout Procedures.
- B. Acceptance of equipment and/or systems shall be signified by execution of Guarantees as described below.

3.05 Guarantees

- A. The equipment and installation furnished under Division 26 shall be guaranteed for a period of one (1) year as specified under Section 01 7700, Closeout Procedures.
- B. 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.
 - a. 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.
 - 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.
- C. OWNER's dated signature on these documents shall constitute acceptance for warranty purposes.

End of Section

Section 26 0800

Commissioning of Electrical Systems

Part 1 General

1.01 Section Includes

- A. Requirements for Setup and Calibration of devices and instruments.
- B. Requirements for Start-up of Systems furnished/installed under this Contract.
- C. Calibration equipment requirements.
- D. Sample Forms.

1.02 Related Sections

- A. Division 26: Electrical
- B. Division 40: Process Interconnections
- C. Division 41: Material Process and Handling Equipment
- D. Division 46: Water and Wastewater Equipment

1.03 References

- A. 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.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- 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.

1.05 Project Record Documents

- A. Submit calibration, setup and programming documentation under provisions of Section 01 7700, Closeout Procedures.

1.06 Operation and Maintenance Data

- A. Submit under provisions of Section 01 7700, Closeout Procedures.
- 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).

1.07 Qualifications

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years documented experience.

1.08 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.

1.09 Delivery, Storage and Handling

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 6000, Product Requirements.
- B. Accept products on site in factory containers. Inspect for damage.
- C. Turn products over to OWNER immediately.

Part 2 Products (Not Used)

Part 3 Execution

3.01 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 26 0705.

- E. CONTRACTOR shall energize the equipment/system and perform all setting of equipment limit and safety switches. 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. 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 to OWNER prior to performing any start-up. Start-up shall be scheduled at a time agreed upon by OWNER and CONTRACTOR.
- G. Start-up and operation of the equipment and/or system shall be performed using the manufacturer's Operation and Maintenance Manual. Deficiencies in the O&M Manual noted during Start-up shall be corrected prior to scheduling OWNER's Demonstration as specified under Section 01 7900, Demonstration and Training. Start-up will be witnessed by OWNER.
- 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 OWNER's witnessed all functions and operations required of the equipment and/or system. Four (4) copies of start-up reports, as specified herein and in other Sections, shall be submitted to OWNER.
- I. 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 CONTRACTOR at no additional cost to OWNER. Start-up of the repaired equipment/system shall be witnessed by OWNER.
- 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 26 0710.

3.02 Contractor's Assistance

- A. Setup, calibration, and start-up of equipment as described in Section 26 0705 shall be as required in other Sections of this Specification.
- B. CONTRACTOR shall provide the services of an electrician to assist either 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. CONTRACTOR shall make equipment manufacturers' service representatives available as required to assist in putting equipment into operation.

3.03 Demonstration

- A. Turn over the calibration equipment at the time of, and as a condition of, acceptance.
- B. After acceptance of the calibration equipment, OWNER's operators shall be provided with one day (in 1/2-day sessions) of onsite training in the use and maintenance of each piece of the equipment. Training shall cover the operation of the calibration equipment, preventative maintenance of equipment, and troubleshooting and repair/replacement procedures.

End of Section

Section 26 0900

Instrumentation and Control for Electrical Systems – General

Part 1 General

1.01 Section Includes

- A. General requirements for electrical power, instrumentation, and controls systems.

1.02 References

- A. 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.

1.03 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, CONTRACTOR shall secure such permits and pay all fees.
- B. Where any public or private utilities are encountered, 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. 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 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.

1.04 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. CONTRACTOR will be allowed no claim(s) for extra(s) due to his failure to make the above examination.

1.05 Inspection

- A. At the proper time, CONTRACTOR shall file application for inspection of his work with the local, State, or National authority having jurisdiction and shall deliver to OWNER all required certificates attesting to approval by such authorities.

1.06 Guarantee

- A. The equipment and installation furnished under this Section shall be guaranteed for a period of one (1) year as specified under Section 01 7700, Contract Closeout, except as modified by the Division 26 specifications.
- B. Repair and maintenance for the guarantee period is the responsibility of CONTRACTOR and shall include all repairs and maintenance other than that which is considered as routine. (This is replacement of lamps, oiling, greasing, etc.) OWNER shall be the judge of what shall be considered as routine maintenance.

Part 2 Products

2.01 Materials and Equipment

- A. Materials and equipment shall be new, except where specifically identified otherwise.
- B. 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 26 Sections.
- C. All conductor terminations, lugs, and connectors on all equipment supplied under this Contract shall be 75 degrees Celsius rated for copper conductors.
- D. Concrete for electrical work shall be ready-mix or transit mixed concrete to the requirements of ASTM C94, latest edition. Concrete shall have a compressive strength, after twenty-eight (28) days, of 3,500 psi (minimum).

2.02 Loose and Detachable Parts

- A. 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 OWNER or his representative delegated to receive them and obtain from OWNER an itemized receipt, therefore, in triplicate, OWNER retaining the original. 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.

2.03 Standards

- A. 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.

2.04 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 OWNER. Spare fuses are specified under Section 26 0705.
- 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

3.01 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 CONTRACTOR shall be completely protected against damage, pilferage, dampness, or abuse until turned over and accepted by OWNER.
- C. Concrete shall be maintained in moist condition for at least five (5) days after placement, by means approved by 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.

3.02 Drawings and Measurements

- A. Drawings shall be submitted in accordance with Sections 01 3300 and 01 7700 of these Specifications and as specified hereinafter. No work shall be undertaken until ENGINEER has reviewed and approved the shop drawings. Only approved materials shall be installed, and only approved installation methods shall be used.
- B. Contract 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; CONTRACTOR shall field verify exact locations.

- C. Contract 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 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 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 OWNER. Wire and terminal numbers shall be clearly shown.
- F. Upon completion of the work, complete record drawings shall be provided in accordance with Section 01 7700, Closeout Procedures,

3.03 Storing of Equipment

- A. Equipment shall be stored in accordance with the manufacturer's recommendations. A letter from the manufacturer shall be provided stating those recommendations.
- B. 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 OWNER.
- C. 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.

3.04 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 OWNER.

3.05 Painting

- A. 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. 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 OWNER, been seriously damaged, the equipment shall be refinished as specified in Section 09 9000, Painting.

3.06 Salvaged Electrical Equipment

- A. All electrical equipment in the existing treatment facility that is removed and not reused shall be turned over to OWNER or disposed of as directed by OWNER.

3.07 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 OWNER can occupy the facilities and/or utilize the system for its intended use.
- B. Substantial Completion shall be determined by OWNER and/or ENGINEER based on completion of Testing, Start-up, and Demonstration requirements as specified in Sections 26 0705, 26 0710, and 26 0800. See Section 01 7700, Closeout Procedures for additional requirements.

End of Section

Section 26 0913.13

Actuators and Operators

Part 1 General

1.01 Scope of Work

- A. This section includes electric motor operated actuators for 90° and multi-turn/rising stem applications. Actuators shall be used for open/shut and modulating/throttling service.
- B. The actuators specified herein shall be provided by the manufacturer of the gates specified in Section 40 0560.

1.02 Related Work Specified Elsewhere

- A. Division 26: Electrical
- B. Section 40 0560: Hydraulic Slide Gates

1.03 Quality Assurance

- A. Actuators specified under this section shall be furnished by one manufacturer who is fully experienced, reputable, and qualified in the manufacture of the equipment furnished.
- B. Actuators and all related equipment shall be designed, constructed, and installed with the best practices and methods.

1.04 Submittals

- A. General:
 - 1. Submit to ENGINEER, in accordance with the requirements of Section 01 3300 complete shop drawings and schematics which shall show details of installations and connections to work of other sections.
 - 2. Furnish catalogue data and parts schedule in sufficient detail to serve as a guide in assembly, disassembly of the actuator and in ordering repair parts.
- B. Certificates: The manufacturer shall provide an affidavit of compliance with all applicable provisions of this specification.
- C. Operation and Maintenance Data: Submit operating instructions, repair parts listing and recommended maintenance schedule of inspection, cleaning and lubrication.
 - 1. Include manufacturers recommended lubricants.
- D. Shop Drawings and Product Data: Submit manufacturer's drawings showing the principal dimensions and general construction of and materials used in all parts of the actuator. All actuators shall be manufactured and furnished in accordance with these drawings and specifications.
 - 1. Furnish illustrated catalog data and parts schedule in sufficient detail to serve as a guide in assembly and disassembly of the valve actuator and in ordering repair parts.

- E. Test Reports: Submit copies of tests and inspection data to ENGINEER for review and record in accordance with the requirements of these Contract Documents.
- F. Actuator: Actuator shall be submitted with the equipment it will operate and will not be accepted as a stand alone submittal. Actuator sizing and selection shall be as recommended by the gate or valve supplier. CONTRACTOR shall coordinate with the valve or gate supplier to obtain operators of the proper size and type.

1.05 Product Delivery, Storage, and Handling

- A. Storage of Materials and Equipment:
 - 1. CONTRACTOR shall store material and each piece of equipment in accordance with the manufacturer's recommendation for protection from weather, temperature, and moisture contamination.
- B. Handling Materials and Equipment:
 - 1. Material shall be handled in a manner such as to eliminate the possibility of damage, breakage, or chipping in transit or otherwise.

1.06 Startup

- A. Each actuator shall be supplied with a startup kit comprising installation instruction, electrical wiring diagram, and sufficient spare cover screws and seals to make good any site losses during the commissioning period.

1.07 Performance Test Certificate

- A. Each actuator must be performance tested and individual test certificates shall be furnished to OWNER. The test equipment should simulate a typical valve load and the following parameters should be recorded:
 - 1. Current at maximum torque setting
 - 2. Torque at maximum torque setting
 - 3. Flash Test Voltage
 - 4. Actuator Output Speed or Operating Time
- B. In addition, the test certificate should record details of specification, such as gear ratios for both manual and automatic drive, closing direction, and wiring diagram code number.

1.08 Warranty

- A. Each actuator shall be warranted for a minimum of 24 months of operation up to a maximum of 36 months from shipment.

1.09 Experience

- A. Technologies and devices used in the actuator must have a minimum of five years' of commercial operating experience for that specific manufacturer, including torque and position sensing, lubrication, and electrical compartment design.

Part 2 Products

2.01 General

- A. Actuators shall operate on a 480 volt, three-phase, 60 Hertz power supply and are to incorporate motor, solid state integral reversing starter, local control facilities, and terminals for remote control and indication connections.
- B. It shall be possible to carry out the setting of the torque, turns, and configuration of the indication contacts without the necessity to remove any electrical compartment covers.

2.02 Actuator Sizing

- A. Actuator shall be sized to guarantee valve closure at the specified differential pressure.
- B. 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.
- C. Operating speed shall be such as to give valve closing and opening at approximately 60 seconds, unless otherwise stated in the job specification.
- D. Actuator shall be capable of functioning in an ambient temperature ranging from -22 degrees to +158 degrees Fahrenheit.

2.03 Motor

- A. The electric motor shall be Class F insulated with a time rating of at least 15 minutes at 104 Fahrenheit (40 degrees Celsius) or twice the valve stroking time, whichever is the longer, at an average load of at least 33% of maximum valve torque.
- B. Electrical and mechanical disconnection of the motor should be possible without draining the lubricant from the actuator gear case. Plugs and sockets are not acceptable as a means of electrical connection for the motor.

2.04 Motor Protection

- A. Protection shall be provided for the motor as follows:
 - 1. Motor shall be de-energized in the event of stall when attempting to unseat a jammed valve.
 - 2. Motor temperature shall be sensed by a thermostat to protect against overheating.

2.05 Gearing

- A. Actuator gearing shall be totally enclosed in an oil- filled gear case suitable for operation at any angle. Where the actuator operates gate valves or large diameter ball or plug valves, the drive shall incorporate a lost-motion hammer blow feature.
- B. For rising spindle valves, the output shaft shall be hollow to accept a rising stem and incorporate thrust bearings of the ball or roller type at the base of the actuator, and the design should be such as to permit the gear case to be opened for inspection or disassembled without releasing the stem thrust or taking the valve out of service.

- C. Standard SAE80EP or Dextron II gear oil shall be used to lubricate the gear case. Special or exotic lubricants shall not be used.

2.06 Hand Operation

- A. A handwheel shall be provided for emergency operation engaged when the motor is declutched by a lever or similar means; the drive being restored to power automatically by starting the motor.
- B. Hand/Auto selection lever should be padlockable in both "Hand" and "Auto" positions. It should be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection lever is locked in "Hand" without damage to the drive train.
- C. Handwheel drive must be mechanically independent of the motor drive, and any gearing should be such as to permit emergency manual operation in a reasonable time.
- D. Clockwise operation of the handwheel shall give closing movement of the valve unless otherwise stated in the job specification.

2.07 Drive Bushing

- A. Actuator shall be furnished with a drive bushing easily detachable for machining to suit the valve stem or gearbox input shaft.
- B. Thrust bearings, when housed in a separate thrust base, should be of the sealed-for-life type.

2.08 Torque and Turns Limitations

- A. Torque and turns limitation to be adjustable.
- B. Torque setting: 40% to 100% rated torque.
- C. Torque sensing must be affected directly electrically or electronically. Extrapolating torque from mechanically measured motor speed is not acceptable due to response time.
- D. Torque measurement shall be independent of variations in frequency, voltage or temperature.
- E. "Latching" to be provided for the torque sensing system to inhibit torque off during unseating or during starting in mid-travel against high inertia loads.
- F. The electric circuit diagram of the actuator should not vary with valve type remaining identical regardless of whether the valve is to open or close on torque or position limit.
- G. A setting tool is required for non-intrusive calibration and interrogation of the actuator.
 - 1. Setting tool will provide quick interrogation capabilities as well as security in a non-intrusive intrinsically safe watertight casing.

2.09 Remote Valve/Actuator Control, Status and Alarm Indication

- A. Four contacts shall be provided which can be selected to indicate any position of the valve with each contact externally selectable as normally open or normally closed.
 - 1. Contacts shall be rated at 5A, 250V AC, 30V DC.
- B. As an alternative to providing valve position, any of the four contacts shall be selectable to signal one of the following:
 - 1. Valve Opening or Closing
 - 2. Valve Moving (Continuous or Pulsing)
 - 3. Local Stop Selected
 - 4. Local Selected
 - 5. Remote Selected
 - 6. Open or Close Interlock Active
 - 7. ESD Active
 - 8. Motor Tripped on Torque in Mid-Travel
 - 9. Motor Tripped on Torque Going Open
 - 10. Motor Tripped on Torque Going Closed
 - 11. Pre-Set Torque Exceeded
 - 12. Valve Jammed
 - 13. Actuator Being Operated by Handwheel
 - 14. Lost Main Power Phase
 - 15. Customer 24V DC or 120V AC Supply Lost
 - 16. Battery Low
 - 17. Internal Failure Detected
 - 18. Thermostat Tripped
- C. In the event of a (main) power (supply) loss or failure, the four position contacts must be self latching to maintain interlock capabilities.
- D. The internal circuits associated with the remote control and monitoring functions are to be designed to withstand simulated lightning impulses of up to 2.0 kV.
- E. Operators for valves or gates listed in the valve or gate schedule as throttling service shall have 4-20 mA analog signal setpoint control module.

2.10 Local Valve/Actuator Control, Status and Alarm Indication

- A. The following Control, Status and Alarm indication shall be available locally at the actuator:
 - 1. Control:
 - a. Open/Stop/Close
 - b. Desired Valve Position Control
 - c. Positioning Units shall have a 4-20 mA input setpoint control module.
 - 2. Status:
 - a. Motor Running Open Direction
 - b. Motor Running Closed Direction
 - c. Fully Open
 - d. Fully Closed

- e. Percentage Open
- f. Percentage Torque

3. Alarms:

- a. Communications Failure
- b. Actuator Alarm
- c. Valve Alarm
- d. Battery Low Alarm

- B. Actuator must provide a local display of the position of the valve, even when the power supply is not present. The display shall be able to be rotated in 90 degree increments so as to provide easy viewing regardless of mounting position.
- C. Actuator shall include a digital position indicator with a display from fully open to fully closed in 1% increments with $\pm 1/2\%$ accuracy. Red, green, and yellow lights corresponding to Open, Closed, and Intermediate positions shall be included on the actuator. The digital display shall be maintained even when the power to the actuator is isolated.
- D. Local display should be large enough to be viewed from a distance of six feet (6') when the actuator is powered up.

2.11 Integral Starter and Transformer

- A. Reversing starter, control transformer, and local controls shall be integral with the valve actuator, suitably housed to prevent breathing and condensation buildup.
 - 1. For Open-Shut service, the starter shall be an electromechanical type suitable for 60 starts per hour and of rating appropriate to motor size.
 - 2. For positioning or throttling service, the starter shall be solid state suitable for excess of 2000 starts per hour.
- B. The controls supply transformer shall be fed from two of the incoming supply voltage and shall have the necessary tapings and be adequately rated to provide power for the following functions:
 - 1. 120V AC energization of the contactor coils
 - 2. 24V DC output where required for remote controls
 - 3. Supply for all the internal electrical circuits
- C. The primary and secondary windings shall be protected by easily replaceable fuses.

2.12 Integral Push Buttons and Selector

- A. Integral to the actuator shall be local controls for Open, Close, and Stop, and a local/remote selector
- B. Switch, padlockable in any one of the following three positions:
 - 1. Local Control Only
 - 2. Off (No Electrical Operation)
 - 3. Remote Control plus Local Stop Only.

- C. It shall be possible to select maintained or non-maintained local control.
- D. Selection of maintained or push-to-run control for (A) above shall be provided. It shall be possible to reverse valve travel without the necessity of stopping the actuator. Starter contactors shall be protected from excessive current surges during travel reversal by an automatic time delay on energization of approximately 300 ms.

2.13 Wiring and Terminals

- A. Internal wiring shall be of tropical grade PVC insulated stranded cable of appropriate size for the control and three- phase power. Each wire shall be clearly identified at each end.
- B. Terminals shall be embedded in a terminal block of high tracking resistance compound.
- C. Terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal.
- D. Terminal compartment of the actuator shall be provided with a minimum of three threaded cable entries. When required, a fourth cable entry shall be provided.
- E. Wiring supplied as part of the actuator to be contained within the main enclosure for physical and environmental protection. External conduit connections between components are not acceptable.
- F. Control logic circuit boards and relay boards must be mounted on plastic mounts to comply with double insulated standards. No more than a single primary size fuse shall be provided to minimize the need to remove single covers for replacement.
- G. A durable terminal identification card showing plan of terminals shall be provided attached to the inside of the terminal box cover indicating:
 - 1. Serial Number
 - 2. External Voltage Values
 - 3. Wiring Diagram Number
 - 4. Terminal Layout
- H. This must be suitable for CONTRACTOR to inscribe cable core identification beside terminal numbers.

2.14 Enclosure

- A. Actuators shall be "O" ring sealed, watertight to NEMA 6, and shall at the same time have an inner watertight and dustproof "O" ring seal between the terminal compartment and the internal electrical elements of the actuator fully protecting the motor and all other internal electrical elements of the actuator from ingress of moisture and dust when the terminal cover is removed on site for cabling.
- B. Enclosure must allow for temporary site storage without the need for electrical supply connection.
- C. External fasteners should be of stainless steel.

2.15 Acceptable Manufacturers

- A. Rotork Controls

Part 3 Execution

3.01 Contractor's Verification

- A. CONTRACTOR shall field measure all dimensions and check possible interferences for the valve actuator system and accessories.

3.02 Preparation

- A. Valve actuators and accessories shall be free of all foreign matter.
- B. Accumulations of dirt, rust, scale, etc., shall be removed prior to installation.
- C. Connections and terminals shall checked to ensure integrity.

3.03 Installation

- A. Install all items in accordance with printed instructions of manufacturers, as indicated and specified. Make adjustments necessary to place equipment in satisfactory working order.
- B. Valve actuators shall be aligned and supported in such manner that no load or thrust will be exerted upon the equipment or the piping at installation or in operating conditions.
- C. Joint connections shall be as indicated on the Plans and specified herein. Excluding connections for valves, fittings, equipment, etc., joints in the pipe line shall be minimal yet provide easy access as required for maintenance.

3.04 Acceptance Test

- A. Complete installation.
- B. Furnish labor, equipment, and materials necessary to conduct tests.
- C. Give each actuator a running test fully opening and closing the valve or gate in the presence of ENGINEER to demonstrate satisfactory operation.
- D. Correct all defects and replace any defective equipment. Make necessary adjustments at no additional cost to OWNER.
- E. Repeat tests if necessary at no additional cost to OWNER to obtain results acceptable to ENGINEER.

3.05 Field Quality Control

- A. Installed actuators shall be tested over their whole range of service and operating conditions.
- B. Valve and actuator shall function as an integral whole in modulating service as intended, and shall operate without "hunting", widely fluctuating or excessive cycling.

- C. Testing shall be made with the temperatures of surrounding air and test water approximately constant within operating temperature ranges.

End of Section

Section 26 1216.13

Dry Type Transformers

Part 1 General

1.01 Section Includes

- A. Dry type two winding transformers.

1.02 Related Sections

- A. Section 26 0526
- B. Section 26 0529
- C. Section 26 0553
- D. Section 26 0533.23

1.03 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.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- 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.

1.05 Quality Assurance

- A. Perform Work in accordance with NECA Standard of Installation.

1.06 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.

1.07 Delivery, Storage and Handling

- A. Store, protect, and handle products to site under provisions of Section 01 6000, Product Requirements.
- 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

2.01 Dry Type Transformers

- A. 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. 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 Contract Drawings.
- D. 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. 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 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.

2.02 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

3.01 Examination

- A. Verify installation conditions.
- B. Verify that surfaces are suitable for installing transformer supports.

3.02 Preparation

- A. Provide concrete pad for floor mounted transformers under provisions of Section 03 3000.

3.03 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 26 0533.13, 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 26 0526.
- F. The transformer windings shall be single phase or three phase, as shown on the Contract 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 (3) certified copies of all test reports shall be furnished OWNER for approval prior to shipment together with a description of how the test was made.
- H. See Section 26 0553, Identification for Electrical Systems for marking and labeling requirements.

3.04 Field Quality Control

- A. Field inspection and testing will be performed under provisions of Section 26 0705, Electrical Testing and Equipment.
- 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

Section 26 2416 Panelboards

Part 1 General

1.01 Section Includes

- A. Distribution panelboards.
- B. Lighting panelboards.

1.02 Related Sections

- A. Section 26 0500: Common Work Results for Electrical
- B. Section 26 0510: Basic Electrical Materials and Methods
- C. Section 26 0529: Hangers and Supports for Electrical Systems
- D. Section 26 0553: Identification for Electrical Systems

1.03 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.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- 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.

1.05 Project Record Documents

- A. Submit under provisions of Section 01 7700, Closeout Procedures.
- B. Record actual locations of Products; indicate actual branch circuit arrangement.

1.06 Operation and Maintenance Data

- A. Submit under provisions of Section 01 7700, Closeout Procedures.
- B. Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.07 Quality Assurance

- A. Perform Work in accordance with NECA Standard of Installation.

1.08 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**2.01 Distribution Panelboards**

- A. 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. Fronts shall be designed for surface or floor mounting as shown on the Drawings. Doors shall be equipped with flush hinges and locks. Locks shall be keyed alike and six keys shall be furnished and delivered to 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. Panelboards shall be of the circuit breaker type and shall be designed for 600-volt, 3 phase, 3 wire, 60 Hertz alternating current service, and shall be service entrance rated. Panelboards shall be equipped with main circuit breaker 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 degrees Celsius rated for copper conductors.
- C. 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. Panelboards shall be Eaton Cutler-Hammer Pow-R-Line 4B, Square D by Schneider Electric I-Line Type HCM, or General Electric Type CCB.

2.02 Lighting Panelboards

- A. Lighting panelboards shall be factory assembled for 208Y/120 volt, three phase, 4 wire, solid neutral service as shown on the Drawings, with ground bus. Panelboards shall have main circuit breakers with single, two, or three pole circuits as indicated on the Drawings.
- B. 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. 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. 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. Panels shall be provided with a directory on the inside of the door. Card shall be protected by a permanently transparent plastic window.

Part 3 Execution

3.01 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 26 0529.
- 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 26 0553.
- 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 26 0553.

3.02 Field Quality Control

- A. Field inspection and testing will be performed under provisions of Sections 01 4500 and 26 0705.

- 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

Section 26 2416.13

Panel Components and Devices

Part 1 General

1.01 Section Includes

- A. Panel components and devices, and associated appurtenances.

1.02 Related Sections

- A. Section 26 0705: Electrical Testing and Equipment
- B. Section 26 0710: Demonstration and Training for Electrical Systems
- C. Section 26 0800: Commissioning of Electrical Systems
- D. Section 26 0900: Instrumentation and Control for Electrical Systems - General

1.03 Regulatory Requirements and References

- A. Conform to requirements of NFPA 70 National Electrical Code.
- B. Furnish Products listed and classified by Underwriters Laboratories, Inc. (UL), Factory Mutual (FM), and/or Canadian Standards Association (CSA), as specifically indicated, as acceptable to the authority having jurisdiction, and as suitable for purpose Specified, and as indicated on the Drawings.
- C. All equipment and workmanship shall be in conformance with all applicable standards and requirements of any and all Federal, State, and/or local codes, ordinances, or regulations, including OSHA/MIOSHA.
- D. All Products shall meet the latest approved standards of ISA, IEEE, ANSI, NEMA, and Underwriters' Laboratories, including, but not limited to:
- E. ANSI/ISA applicable standards for measurement and instrumentation.
- F. NEMA, including ICS 1 – General Standards for Industrial Control Systems, NEMA ICS 2 – Standards for Industrial Control Devices, Controllers and Assemblies, and NEMA ICS 6 – Enclosures for Industrial Controls and Systems.

1.04 Submittals

- A. Submittals shall be as required under provisions of Division 1 and Section 26 0900, Instrument and Control Requirements for Electrical Systems - General. Shop Drawings shall indicate electrical characteristics and connection requirements, including layout of complete assemblies, interconnecting cabling, dimensions, weights, and external power requirements for each Product supplied. Provide Product Data showing manufacturer's specifications, electrical characteristics, and connection requirements for each Product supplied.
- B. Include application and installation instructions indicating all conditions and limitations of use stipulated by the manufacturer, and/or Product Testing Agency, and any instructions for storage, handling, protection, examination, preparation, installation, and starting for each Product supplied.

1.05 Project Record Documents

- A. Submit under provisions of Division 1; Section 26 0705, Electrical Testing and Equipment; and Section 26 0710, Demonstration and Training for Electrical Systems.
- B. Record actual locations of primary devices, and other devices connected to instruments. Include interconnection wiring and cabling information, and all terminal arrangements.

1.06 Operation and Maintenance Data

- A. Submittals shall be as required under provisions of Division 1 and Section 26 0710, Demonstration and Training for Electrical Systems.
- B. Installation and Start-Up Requirements shall be clearly identified, described and/or detailed. Include bound copies of programming and operating instructions.
- C. Maintenance Data shall include component parts diagrams and Lists, calibration, adjustment, and preventative maintenance procedures, troubleshooting procedures, and repair or replacement procedures.

1.07 Qualifications

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years documented experience.
- B. Supplier: Authorized distributor, or representative of specified manufacturer with minimum three years documented experience.

1.08 Delivery, Storage, and Handling

- A. Deliver, store, protect, and handle products as required under the provisions of Division 1, and Section 01 6000.
- B. Accept products on site in factory containers. Inspect for damage. Store products in clean, dry area; maintain temperature to NEMA ICS 1.

1.09 Environmental Requirements

- A. Panel components and devices shall be provided in enclosures, or housings, suitable for the environment of the intended installed location, as shown on the Drawings, and as described hereinbelow. Manufacturer shall provide integral heater(s) and/or cooler(s) where required for proper operation under normally expected conditions. Normal ambient temperatures at the facility site range from minus 30 to plus 45 degrees Celsius (minus 25 to plus 115 degrees Fahrenheit). Instruments in outdoor locations shall be suitable for operation under these conditions, while in direct sunlight, or under windy conditions with associated "chill" factors.
- B. Maintain instruments free of dirt and dust during and after installation.

Part 2 Products**2.01 Instrument and Control Panels - General**

- A. Instrument and control panels shall be furnished as described herein, and as indicated on the Contract Drawings.

2.02 Terminal Blocks – 600 Volts and Less

- A. Terminal blocks shall be as manufactured by Allen Bradley 1492-CA1 or equal by Eaton Cutler-Hammer or Square D.
- B. Each wire for external connection, and other wiring inside enclosures requiring terminal blocks, shall be terminated on screw type compression terminal blocks rated at 600 VAC. Fused terminals shall match the terminal blocks and shall be complete with fuse puller, and fuse.
- C. All foreign circuit 120 VAC wiring shall be yellow, and each foreign circuit shall be provided with a clearly labeled circuit disconnect switch. Foreign circuit disconnect switches shall be switch type terminal blocks complete with engraved nameplates.
- D. Ten percent spare terminals of each type shall be provided.

2.03 Power Distribution Blocks – 600 Volts and Less

- A. Power distribution blocks shall be as manufactured by Allen Bradley 1492-PD type or equal by Eaton Cutler-Hammer or Square D.
- B. Where power is to be distributed among many circuits this shall be accomplished using one, two, or three pole power distribution blocks. The blocks shall be rated for use at 600 VAC and shall have copper connector block construction.

2.04 Manufacturers (Switches and Indicating Lights)

- A. Push-button switches, selector switches, and indicating lights mounted on NEMA Type 1, or NEMA Type 12, enclosures shall be of dust-tight, oil-tight NEMA Type 13 design; as manufactured by Allen-Bradley Bulletin 800T, Eaton Cutler-Hammer 10250T Series, or Square D Type K.
- B. Push-button switches, selector switches, and indicating lights mounted on NEMA Type 3R, or NEMA Type 4, enclosures shall be of watertight, NEMA Type 4 design; as manufactured by Allen-Bradley Bulletin 800T, Square D Type K, Eaton Cutler-Hammer 10250T Series with clear rubber boot and gaskets.
- C. Push-button switches, selector switches, and indicating lights mounted on NEMA Type 4X enclosures shall be of watertight, corrosion resistant, NEMA Type 4X design; as manufactured by Square D Type SK, Allen-Bradley Bulletin 800H with clear rubber boot and gaskets, or Eaton Cutler-Hammer 10250T Series with clear rubber boot and gaskets.
- D. Push-button switches, selector switches, and indicating lights mounted on explosion proof, (Class I, Div. 1, Groups C and D) enclosures shall be of explosion proof design, rated for Class I duty; as manufactured by Allen-Bradley Bulletin 800H, Square D Type BR, Crouse-Hinds Types EFS and EFD, Appleton EFD and EDS Series, or equal by Killark.
- E. Four or more position selector switches shall be rated as indicated above, as a minimum, with the number of contacts as required by the Drawings, shall have pistol grip type handles and shall be as manufactured by Electro Switch Type W-2, American Solenoid Blue Line Type C10, or equal.

2.05 Indicating Lights (LT)

- A. Indicating lights shall be LED, heavy duty, push-to-test, transformer type with lens colors as shown on the Drawings.
- B. Indicating lights shall be equipped with legend plates marked as shown on the Drawings and shall be mounted on remote control stations as specified hereinafter or on other panels as shown on the Drawings.

2.06 Selector Switches (SS)

- A. Selector switches shall be of the two or three position, maintained contact, heavy duty type, with contact arrangement as shown on the Drawings. The contacts shall be rated at least 10 amperes at 600 VAC.
- B. The selector switches shall be equipped with legend plates marked as shown on the Drawings and shall be mounted on remote control stations as specified hereinafter or on other panels as shown on the Drawings.

2.07 Push-Button Switches (PB)

- A. Push-button switches shall be of the heavy duty, momentary contact, industrial type rated for 600 VAC, and the contacts shall be rated for 10 amperes continuous duty at 125 VAC. Push-button switches shall be the guarded type with full shroud and green button for start operation, the unguarded type with red button for stop operation, and the unguarded type with black or gray button for all others.
- B. Push-button switches shall be equipped with legend plates marked as shown on the Drawings and shall be mounted on remote control stations as specified hereinafter or on other panels as shown on the Drawings.

2.08 Emergency Stop-Reset/Jog Pushbutton Switch Stations (ESRJ)

- A. Emergency stop-Reset/Jog pushbutton switch stations shall be of the three push-button operator type with padlocking provision on the Stop button. The switches shall be of the momentary (Reset and Jog buttons) – maintained (Stop button) type. The Stop and Reset operators shall be mechanically interlocked.
- B. Stations shall be rated for installation in hazardous locations; Class I, Division 1; where indicated as explosion proof; and shall be rated NEMA Type 4X for all other locations.
- C. Station enclosure shall be constructed of cast, copper-free aluminum with a corrosion resistant finish.

2.09 Stop-Lockout Switch Stations

- A. Wherever “Emergency stop-Reset”, “Emergency stop lockout”, “Lock stop-Reset”, “Stop lockout-Reset”, or “Stop-Reset” pushbuttons are shown on the Drawings, they shall be two unit, mechanically interlocked, maintained contact type with locking device on stop button, and legend plates shall be “Stop” or “Emergency stop”, as indicated on the Drawings, and “Reset”.
- B. Stations shall be rated for installation in hazardous locations; Class I, Division 1; where indicated as explosion proof; and shall be rated NEMA Type 4X for all other locations.

2.10 Remote Control Stations

- A. Control stations shall be provided and installed where indicated on the Drawings and shall contain the control devices indicated.
- B. Stations shall consist of switches and/or indicating lights mounted in a NEMA Type 4X, or explosion proof enclosure, as indicated on the Drawings. Station enclosures shall be designed for mounting of the control devices required and shall have nameplates as required and specified under Section 26 0553, Identification for Electrical Systems.

2.11 Logic Relays (LR)

- A. Logic relays shall be of the miniature plug-in relay type, suitable for logic duty, with contacts rated not less than 3 amperes at 120 VAC.
- B. The relay coils shall be rated for continuous duty at 120 volts, 60 Hertz. Each logic relay shall have an internal pilot light for indication of coil energization.
- C. The contact arrangement shall be 4PDT. Each relay shall also have a manual operator, to provide for testing the logic circuits by manually operating the contacts.
- D. Each logic relay shall be complete with a double tier, 14 pin (spade type), plug-in base. The bases shall be suitable for either surface or track mounting. Each relay shall be provided with a hold-down device.
- E. Logic relays shall be as manufactured by Square D Class 8501 Type R, Allen-Bradley Bulletin 700 Type P, or equal by IDEC or Potter and Brumfield a division of Tyco Electronics.

2.12 Control Relays (CR)

- A. Control relays shall be of the heavy duty, industrial type with convertible contacts rated not less than 10 amperes at 600 volts AC.
- B. Relay coils shall be of molded construction and shall be rated for continuous duty at 120 volts, 60 Hertz, alternating current.
- C. Contact arrangement shall be as required.
- D. NEMA Type 12 enclosures shall be provided for relays where shown on the Drawings.
- E. Induction relays shall be electro-mechanical type, 120 VAC powered with secondary coil voltage of 24 VAC and one N.O. and one N.C. contact rated 8 amps (min.) at 120 VAC. Induction relay sensitivity shall be field adjustable. Unit shall be suitable for use with contact closure devices.
- F. Control relays shall be as manufactured by Square D Class 8501 Type X, Allen-Bradley Bulletin 700 Type P, Eaton Cutler-Hammer Type ARB, or equal by General Electric.
- G. Induction relays shall be as manufactured by B/W Controls Model 1500-A-L1-S2-DC-X, or Warrick Controls equivalent

2.13 Alternating Relays (ALT)

- A. Duplex alternating relays shall be designed to alternate control of two loads through DPDT contacts. The relays shall be suitable for operation on 120 VAC. The contacts shall transfer on each pulse when the relay's control input is de-energized and shall be rated 5 amps (minimum) at 120 VAC resistive.
- B. Triplex alternating relays shall be designed to alternate control of three loads through SPST contacts. The relays shall be suitable for operation on 120 VAC. The contacts shall transfer on each pulse when the relay's control input is de-energized and shall be rated 2 amps (minimum) at 120 VAC resistive.
- C. The minimum life expectancy of the alternating relays shall be one million operations and each relay shall be equipped with screw terminals for direct wiring.
- D. Duplex alternating relays shall be as manufactured by Diversified Electronics Model No. ARA-120-ADA, or equal, by Time Mark.
- E. Triplex alternating relays shall be as manufactured by Diversified Electronics Model No. ARA-120-AFE, or equal, by Time Mark.
- F. Durant/Eagle Signal Model B856-511, or equal, with plug-in base and HOLD DOWN.

2.14 Phase Monitor Relays (PMR)

- A. Phase monitor relays shall sense phase loss, incorrect phase sequence, and low phase voltage and shall have double pole, double throw contacts. Relays shall operate on an adjustable voltage range of 440 volts to 480 volts. Relays shall have a delay on trip, field adjustable 1 to 10 seconds (minimum) and shall automatically reset when voltage returns to normal. Phase monitor relays shall detect phase loss with regenerated voltages present.
- B. Phase monitor relays shall be as manufactured by Diversified Electronics, Inc. No. SLD-440-ALE, or Time Mark Corp. Model C2642.
- C. Load monitor relays shall be as manufactured by Diversified Electronics, Inc. No. CBA-102-ALE-5, or equal.

2.15 Load Monitor Relays (LMR)

- A. Load monitor relays shall be on the single phase, current monitoring type. Relays shall have adjustable, 1.0 to 5.0 amps, under current and over current ranges and shall operate on a 120 VAC source. Relays shall have an inherent 1.0 second delay, built in current transformer (CT), one set of Form C contacts each for under and over current rated 10 amps at 120 VAC, and shall automatically reset.
- B. Load monitor relays shall be as manufactured by Diversified Electronics, Inc. No. CBA-102-ALE-5, or equal.

2.16 Dc Loop Power Supplies

- A. Separately mounted dc power supplies shall be as manufactured by Acopian, or Power-One.

2.17 Dc Power Supplies

- A. Each instrumentation device requiring a DC power supply shall each be powered by a single 24 VDC minimum, regulated 120 VAC input type power supply. Each power supply may be integral to an indicator or controller in the loop or may be of the separately mounted type. In the case of several instruments in a common case or enclosure, a single DC power supply may be provided for all devices, providing that the distribution of DC power to each device is separately protected by fuse or circuit breaker.
- B. Separately mounted dc power supplies shall be as manufactured by Acopian, or Power-One.

2.18 Elapsed Time Meters (Etm)

- A. Elapsed time meters shall have a range of 0 to 99,999.9 hours and shall be non-reset type suitable for panel mounting, with gasketing as required to maintain panel integrity (NEMA 12 or 4, as required).
- B. Elapsed time meters shall be as manufactured by General Electric Type 240, Simpson, or equal.

2.19 Totalizers (Qi)

- A. Each totalizer shall be a high accuracy, 8-digit, non-reset, front panel mounted instrument with bezel. The input shall be a scaled 24 VDC pulse, with gasketing as required to maintain panel integrity (NEMA 12 or 4, as required).
- B. The electric totalizers shall be as manufactured by Durant, KEP, or Sodecco.

2.20 Panel Heaters

- A. Heaters shall be as manufactured by Hoffman Engineering, or equal. Heaters shall be provided complete with thermostat, ranged 40 to 100 degrees Fahrenheit.
- B. Panel heaters and thermostats shall provide thermostatically controlled protection from low temperatures, and the effects of condensation inside control panels. Heaters shall be of the fan-forced type, to maintain stable temperatures throughout the enclosure.

Part 3 Execution**3.01 Installation**

- A. Install in accordance with manufacturer's instructions.
- B. Do not install products until major construction is complete and building interior is enclosed and heated.
- C. Make all instrumentation interconnections (process, electrical, etc.) as indicated and required for proper operation and intended use.
- D. See Section 26 0553, Identification for Electrical Systems, for nameplate, circuit number marker, and wire marker, etc. requirements.

3.02 Field Quality Control

- A. Field inspection and testing shall be performed under provisions of Section 26 0705, Electrical Testing and Equipment.
- B. Perform operational testing on instrumentation and control systems to verify proper operation and field wiring connections.

3.03 Manufacturer's Field Services

- A. Prepare and start systems under provisions of Section 26 0800, Commissioning of Electrical Systems.
- B. Calibrate and/or verify each device for the zeros, ranges, and spans indicated on the Drawings.

3.04 Demonstration

- A. Demonstrate calibration and operation of devices.
- B. Provide systems demonstration under provisions of Section 26 0710, Demonstration and Training for Electrical Systems.
- C. After acceptance of the equipment, the Owner's operators shall be provided with one-half day (minimum) of onsite training in the use and maintenance of the equipment. Training shall cover the calibration of the devices, preventative maintenance of all equipment, and troubleshooting and repair/replacement procedures.

3.05 Spares

- A. Spares for panel mounted components and devices shall be furnished as Specified under Section 01 6000, Product Requirements.
- B. Turn over all spares at the time of, and as a condition of, acceptance.

End of Section

Section 26 2419 Motor Control Centers

Part 1 General

1.01 Section Includes

- A. Modifications to existing motor control centers.

1.02 Related Sections

- A. Section 26 0500: Common Work Results for Electrical
- B. Section 26 0510: Basic Electrical Materials and Methods
- C. Section 26 0553: Identification for Electrical Systems
- D. Section 26 2416.13: Panel Components and Devices
- E. Section 26 0705: Electrical Testing and Equipment
- F. Section 26 0800: Commissioning of Electrical Systems
- G. Section 26 0710: Demonstration and Training for Electrical Systems
- H. Section 26 2813: Fuses

1.03 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 402-2014 – Motor Control Centers (ANSI).
- E. NEMA AB 1 - Molded Case Circuit Breakers.
- F. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
- G. NEMA ICS 2.3 - Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers.

1.04 Submittals

- A. Submit under provisions of Section 01 3300.
- B. Shop Drawings: Include front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time/current curves of all equipment and components.
- C. Wiring diagrams shall be provided as specified under Section 26 0710.
- D. Test Reports: Indicate field test and inspection procedures and test results.
- E. 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.

- F. 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.

1.05 Operation and Maintenance Data

- A. Submit under provisions of Section 017700.
- B. Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.06 Quality Assurance

- A. Perform Work in accordance with NEMA ICS 2.3.

1.07 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.

1.08 Delivery, Storage, and Handling

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 6000.
- B. Deliver in shipping splits, individually wrapped for protection, and mounted on shipping skids.
- 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 NEMA ICS 2.3. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

1.09 Environmental Requirements

- A. Conform to NEMA ICS 2 service conditions during and after installation of motor control centers.

1.10 Field Measurements

- A. Verify that field measurements are as indicated on the Drawings.

1.11 Extra Materials

- A. Furnish under provisions of Section 01 6000.
- B. Furnish one (1) set of replaceable contacts for each type of relay and each size of contactor or starter installed in motor control centers modified under this Contract.

- C. Furnish three (3) push-to-test indicating light assemblies to match those installed in motor control centers modified under this Contract.
- D. Furnish ten (10) indicating light lamps.
- E. Furnish two (2) indicating light lenses of each color installed in motor control centers modified under this Contract.
- F. Furnish one (1) control switch assembly of each type installed in motor control centers modified under this Contract.
- G. For additional spare parts requirements, see Section 26 0710.

Part 2 Products

2.01 Modifications to Existing Motor Control Centers

- A. The existing motor control centers shall be modified by the addition of new devices and by wiring revisions as shown on the Drawings.
- B. Starters for addition to existing motor control centers shall be of the magnetic type consisting of a circuit protective device in combination with a starter. The circuit protective device shall be a motor circuit protector type, molded case, air circuit breaker with interrupting capacity to match that of existing circuit breakers in the motor control center. The motor starter shall be comprised of NEMA size contactors; three pole, ambient compensating overload relays; interlocks; etc. The combination starters, Sizes 1, 2, and 3, shall be mounted on removable units designed to slide into the existing cubicles with stabs to engage the vertical bus and interlocks on the circuit protective device operating handle to prevent opening the unit door when the breaker is closed or in the "On" position. Individual 120 volt control circuit transformers with fused primary and with fused and grounded secondary shall be provided in each unit. All starters shall have a spare auxiliary contact in addition to those indicated on the Drawings. All coils shall be rated for 120 volts, 60 Hertz operation. Additional control circuit transformer capacity shall be provided as required to safely carry all internal and external loads connected to it.
- C. Replacement or added motor overload protection shall consist of a UL 508 solid-state overload relay for protection of the motors. The relay shall be Allen Bradley type E3 Plus. The overload relay shall be self-powered and provide high accuracy through the use of state-of-the-art microelectronic packaging technology. The relay shall be suitable for application with NEMA Size 1 through Size 7 motor starters.
- D. Devices on the front of unit shall be mounted as part of the removable unit.
- E. Nameplates shall be installed on the door of each unit and shall be attached by means of corrosion resistant screws. The plates shall be 1-1/4" high by 3-1/2" wide (minimum), white laminated plastic with engraved black letters. Letters shall be 1/8" high (minimum), block type. Nameplate engraving shall be as indicated in schedules on the Drawings, except nameplates for spare units shall be furnished blank. See the Drawings for nameplate details.
- F. All equipment devices mounted within the units shall be identified as to function and schematic identification abbreviation. Identification plates shall be 1" by 3" engraved white lamicaid with black letters, attached with corrosion resistant screws.

- G. Circuit protective devices shall be provided in accordance with the Short Circuit and Protective Devices Coordination Analyses specified under Section 26 0705.
- H. Added control devices shall be as specified in Section 26 0900.
- I. Branch feeder protection shall be thermal magnetic, molded case, circuit breakers of frame and ratings sizes as indicated on the Drawings and with interrupting capacity to match that of existing circuit breakers in the motor control center. Circuit breakers shall have auxiliary normally open and normally closed contacts and Devicenet System Accessory for connection to the MCC PLC.
- J. The number and size of starters, contactors, and branch feeder circuit breakers added to each motor control center shall be as indicated on the Drawings and shall fit into the space shown.
- K. Each added or modified starter, contactor, and/or circuit breaker 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 volt power wiring, all 120 volt 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.
- L. Terminal blocks shall be installed, where required, to provide terminal block connections for all wiring to devices external to the motor control centers. All power feeder terminals or lugs shall be 75°C rated for copper conductors. Terminal blocks for control and alarm connections shall match the existing terminal blocks or shall be Allen-Bradley Types CA-1, CA-3, or CD-8; Square D Co.; or equal.
- M. Wire for control and alarm wiring revisions within the motor control centers shall be No. 14 AWG minimum, Type MTW, 60°C. All wiring installed within a motor control center, which is powered from sources external to the MCC, shall be color coded yellow.
- N. All door mounted control devices shall be furnished with anti-rotation keyways or other device to prevent slewing after mounting. Existing motor control centers are Allen-Bradley IntelliCENTER - Centerline Bulletin 2100.

Part 3 EXECUTION

3.01 Examination

- A. Verify conditions under the provisions of Section 01 6000.
- B. Verify that area is suitable for motor control center installation.

3.02 Installation

- A. Install motor control center components in accordance with manufacturer's instructions and per NECA 402-2014 Standards.
- B. Tighten accessible bus connections and mechanical fasteners after placing motor control center.
- C. Install fuses in fusible switches.

- D. Select and install heater elements or set solid state overload relays in motor starters to match installed motor characteristics. CONTRACTOR shall assume full responsibility for the selection and installation of the proper rating of thermal heater elements or the settings on solid state overload relays in all motor starters to which CONTRACTOR makes the feeder connections and/or completely wires.
- E. Provide labels and engraved plastic nameplates under the provisions of Section 26 0553.
- F. Motor Data: Provide neatly typed label inside each motor starter 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 an upper door of each vertical section and shall be marked as specified in Section 26 0553.

3.03 Field Quality Control

- A. Field inspection and testing shall be performed under provisions of Sections 01 4500 and 26 0705.
- B. Inspect and test each added or modified controller to NEMA ICS 2.

End of Section

Section 26 2716

Cabinets and Enclosures

Part 1 General

1.01 Section Includes

- A. Hinged cover enclosures.
- B. Cabinets.
- C. Terminal boxes.
- D. Accessories.

1.02 Related Sections

- A. Section 26 0500: Common Work Results for Electrical
- B. Section 26 0510: Basic Electrical Materials and Methods
- C. Section 26 0533.23: Surface Raceways for Electrical Systems
- D. Section 26 0533.16: Boxes for Electrical Systems
- E. Section 26 0529: Hangers and Supports for Electrical Systems
- F. Section 26 0553: Identification for Electrical Systems

1.03 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.

1.04 Submittals

- A. Submit under provisions of Section 01 3300.
- 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 CONTRACTOR and delivered to 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.

1.05 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.

1.06 Extra Materials

- A. Furnish under provisions of Section 01 7700.
- B. Provide three (3) of each cabinet key.

Part 2 Products

2.01 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.

2.02 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.

2.03 Terminal Boxes

- A. Explosion proof terminal boxes for connection of the submersible dewatering and sample pump motor cable(s) shall be provided where shown on the Drawings. The terminal box shall be 12" high by 18" wide by 8" deep minimum with internal mounting plate for terminal blocks, cast iron or cast aluminum with external mounting ears for surface mounting, 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 terminal 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. Control terminal blocks and conductors shall be coated with a conformal coating compound after permanent terminations have been completed. Conformal coating compound shall be Chemtronics Konform, GC Electronics Conkoat, or equal. Provide an engraved, laminated plastic instruction plate, adjacent to the control terminal block, engraved: "RECOAT CONTROL TERMINATIONS WITH CONFORMAL

COATING COMPOUND AFTER EACH RETERMINATION OF CONDUCTORS TO PREVENT NUISANCE MOTOR LEAK ALARMS".

- 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 No. EJB181208-N4-MP-S598-S391, or equal.

2.04 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, CRC Chemicals Lectra-Shield, Crouse-Hinds HTL, Sanchem, Inc. NO-OX-ID "A Special", or equal.

Part 3 Execution

3.01 Examination

- A. Verify installation conditions under provisions of Section 01 6000.
- B. Verify that surfaces are ready to receive work.

3.02 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 26 0533.23, Raceways for conduit entrance to cabinets and enclosures requirements.

- I. Mark or label all boxes, cabinets, and enclosures as specified in Section 26 0553.
- 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.
- L. Termination of the submersible dewatering and sample pump motor cable(s) at the terminal box shall incorporate a cord connector, a sealing fitting, and an explosion proof union fitting for each cable. The end of the cable's overall jacket shall be potted within the seal-off fitting in accordance with Article 501.5(D) of the National Electrical Code. The cable's overall jacket shall be stripped back to provide sufficient lengths of individual conductors for proper termination within the terminal box.

End of Section

Section 26 2726

Wiring Devices

Part 1 General

1.01 Section Includes

- A. Wall switches.
- B. Receptacles.
- C. Device plates and box covers.

1.02 Related Sections

- A. Section 26 0500: Common Work Results for Electrical
- B. Section 26 0510: Basic Electrical Materials and Methods
- C. Section 26 0533.16: Boxes for Electrical Systems

1.03 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.

1.04 Submittals for Review

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, materials, finishes, and configurations.
- C. Submit manufacturer's installation instructions.

1.05 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

2.01 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. Where pilot lights are indicated, provide switches as specified above plus a separate pilot receptacle with plate and bull's eye in a two gang box.
- D. Lighting switches shall be Hubbell Series HBL1220, Leviton Series 1220, General Electric GE5951, Cooper Wiring Devices, or equal.
- E. 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.

2.02 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.

2.03 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.

2.04 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. 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 0.040-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

3.01 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.

3.02 Preparation

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean debris from outlet boxes.

3.03 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. 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 26 0553 for nameplate, circuit number marker, wire marker, etc. requirements.

3.04 Interface with Other Products

- A. Coordinate locations of outlet boxes provided under Section 26 0533.16 to obtain mounting heights specified or indicated on the Drawings.

3.05 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.

3.06 Adjusting

- A. Adjust devices and wall plates to be flush and level.

3.07 Cleaning

- A. Refer to Section 01 7700, Closeout Procedures with regard to cleaning installed work.
- B. Clean exposed surfaces to remove splatters and restore finish.

End of Section

Section 26 2813

Fuses

Part 1 General

1.01 Section Includes

- A. Fuses.

1.02 Related Sections

- A. Section 09 9000: Painting and Coating
- B. Section 26 0500: Common Work Results for Electrical
- C. Section 26 0510: Basic Electrical Materials and Methods

1.03 References

- A. NFPA 70 - National Electric Code.
- B. NEMA FU 1 - Low Voltage Cartridge Fuses.

1.04 Submittals

- A. Submit under provisions of Section 01 3300.
- B. Product Data: Provide data sheets showing electrical characteristics including time-current curves and fuse let-through values for fault current available.

1.05 Project Record Documents

- A. Submit under provisions of Section 01 7700.
- 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.

1.06 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.

1.07 Maintenance Materials

- A. Provide maintenance materials under provisions of Section 01 7700.
- B. Provide two fuse pullers.

1.08 Extra Materials

- A. Furnish under provisions of Section 01 6000.

- B. Provide ten (10) spare fuses of each size and type, rated 600 VAC and lower, installed.
- C. Provide three (3) spare fuses of each size and type, rated higher than 600 VAC, installed.
- D. For additional spare parts requirements, see Section 26 0710.

Part 2 Products

2.01 Manufacturers

- A. Bussmann
- B. Mersen
- C. Edison
- D. Littelfuse

2.02 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 the equipment furnished, and as shown on the Drawings. Fuses shall provide type II protection for motor circuits.

Part 3 Execution

3.01 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. 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 26 2816.16 Enclosed Switches

Part 1 General

1.01 Section Includes

- A. Non-fusible disconnect switches.

1.02 Related Sections

- A. Section 26 0500: Common Work Results for Electrical
- B. Section 26 0510: Basic Electrical Materials and Methods
- C. Section 26 0533.16: Boxes for Electrical Systems
- D. Section 26 2716: Electrical Cabinets and Enclosures
- E. Section 26 0526: Grounding and Bonding for Electrical Systems
- F. Section 26 0529: Hangers and Supports for Electrical Systems
- G. Section 26 0553: Identification for Electrical Systems
- H. Section 26 2813: Fuses

1.03 References

- A. NEMA KS 1 - Enclosed Switches.
- B. NFPA 70 - National Electrical Code.

1.04 Submittals

- A. Submit under provisions of Section 01 3300.
- 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.

1.05 Quality Assurance

- A. Perform Work in accordance with NECA Standard of Installation.

1.06 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

2.01 Disconnect Switches

- A. 600 volt rated, NEMA 4X enclosed disconnect switches shall be Eaton Cutler-Hammer, Square D by Schneider Electric, or General Electric.
- B. Auxiliary interlocks shall be provided where shown on the Drawings.
- C. 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.
- D. Enclosures shall be NEMA Type 4X stainless steel, or explosion proof, as indicated on the Drawings.
- E. Combination drain and breather shall be Crouse-Hinds ECD Combination Series, Appleton, or equal.

Part 3 Execution

3.01 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 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 26 0553.

End of Section

Section 26 2923

Variable Frequency Controllers

Part 1 General

1.01 Section Includes

- A. Low Harmonic type, twelve (12) pulse variable frequency controllers.

1.02 Related Sections

- A. Section 26 0500: Common Work Results for Electrical
- B. Section 26 0510: Basic Electrical Materials and Methods
- C. Section 26 0526: Grounding and Bonding for Electrical Systems
- D. Section 26 0553: Identification for Electrical Systems
- E. Section 26 0705: Electrical Testing and Equipment
- F. Section 26 0710: Demonstration and Training for Electrical Systems
- G. Section 26 0800: Commissioning of Electrical Systems
- H. Section 26 2416.13: Panel Components and Devices

1.03 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).

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- 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 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.
- F. Manufacturer's Field Reports: Indicate start-up inspection findings.

1.05 Operation and Maintenance Data

- A. Submit under provisions of Section 01 3300, Submittal Procedures and Section 01 6000, Product Requirements.

- 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.

1.06 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.

1.07 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.

1.08 Delivery, Storage and Handling

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 6000, Product Requirements.
- 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.

1.09 Field Measurements

- A. Verify that field measurements are as indicated on shop drawings.

1.10 Extra Materials

- A. Furnish under provisions of Section 01 6000, Product Requirements.
- 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 26 0705 and Section 26 0710

Part 2 Products

2.01 Manufacturers

- A. Allen-Bradley
- B. General Electric Company
- C. Eaton Cutler-Hammer
- D. Square D/Schneider Electric
- E. Substitutions: Under provisions of Section 01 2513, Substitution Procedures.

2.02 Variable Frequency Controllers (VFD) Description

A. General

1. 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.
2. 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.
3. 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.
4. 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. These controls shall be operable in both the VFD and Bypass modes.
5. VFDs shall utilize a Voltage Source Pulse Width Modulated (PWM) technique for producing adjustable frequency speed control.
6. VFD shall include output short circuit protection for line-to-line and line-to-ground faults.
7. 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.
8. 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.
- 9. A harmonic analysis of the system shall be made consisting of the current and voltage harmonics expected from the addition of the adjustable frequency drives for all harmonics through the 25th per Tables 10-2 and 10-3 of IEEE 519-2014. This analysis shall be included as part of the bid submittal.
- B. Specific Design Requirements for Low Harmonic Type VFD Units (For units less than 100 Hp).
 - 1. VFD shall be sinusoidal input type which provides low harmonic (nearly clean) power operation to power source. Operation of VFD shall not add more than 5% total harmonic voltage distortion and no more than 15% total harmonic current distortion to the worst-case point of common coupling. VFD control shall also include transient voltage suppression to allow reliable operation on a typical industrial power distribution system.
 - 2. VFD shall be of the twelve (12) pulse rectifier and pulse width modulated (PWM) design, and shall provide microprocessor based, software programmable protection and operation of a three-phase motor.
 - 3. A wall mounted NEMA Type 12 enclosure shall be provided for the VFD unit.
 - 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.

2.03 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 200,000 AIC or circuit breaker rated 65,000 AIC for fault current protection of AC and DC converter section.
- 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.

2.04 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: ± 10 percent.
- D. Current Limit Adjustment: 60 to 110 percent of rated.
- E. Acceleration Rate Adjustment: 0.5 to 30 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. An "Emergency Stop" circuit shall utilize dynamic braking.
- L. 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.
- M. 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.
- N. Laminated plastic nameplate engraved with the drive's designation, as indicated on the Drawings.
 - O. 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.
 - P. VFD shall include digital communications. Ethernet protocol shall be provided to allow direct communication with a programmable logic controller. An RS-232, RS-422, or RS-485 port shall be provided for communication.

2.05 Fabrication

- A. VFD systems shall be fabricated by the same VFD manufacturer, to assure a properly coordinated system.
- B. 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 units shall fit within the available space indicated on the Drawings.

Part 3 Execution

3.01 Factory Testing

- A. The following standard factory tests shall be performed on the equipment provided under this Section. Tests shall be in accordance with the latest version of UL and NEMA standards.
 1. Printed circuit boards shall be tested under a temperature cycling (0 degrees Celsius to +50 degrees Celsius) 24-hour load test and then functionally tested via fault finder bench equipment prior to unit installation.
 2. Final assemblies shall be tested at full load with application of line-to-line and line-to-ground bolted faults. Adjustable Frequency Drive shall trip electronically without device failure.
 3. After tests have been performed, each VFD shall undergo a 12-hour burn-in test. The drive shall be burned in at 100% inductive or motor load for 12 hours without an unscheduled shutdown.

4. After the burn-in cycle is complete, each VFD shall be put through a 30-minute cycling motor load test before inspection and shipping.
- B. Factory tests as outlined above shall be witnessed by OWNER (100 Hp units and larger only).
1. Notify OWNER two (2) weeks prior to the date the tests are to be performed.
 2. Include the cost of transportation and lodging for up to three (3) of OWNER's personnel; cost of meals and incidental expenses shall be OWNER's responsibility.
- C. Manufacturer shall provide three (3) certified copies of factory test reports.

3.02 Examination

- A. Verify that surface is suitable for controller installation.
- B. Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.

3.03 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 26 0553, Electrical Identification.
- 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 26 0553, Electrical Identification.
- H. Install the motor leads in grounded metal conduit or provide shielded cable motor leads with the shield grounded.

3.04 Field Quality Control

- A. Provide the services of a qualified factory-trained manufacturer's representative to assist CONTRACTOR in installation and start-up of the equipment specified under this Section. Manufacturer's representative shall provide technical direction and assistance to 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 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.
- C. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.
- D. CONTRACTOR shall provide three (3) copies of the manufacturer's field start-up report.

3.05 Manufacturer's Field Services

- A. Prepare and start systems under provisions of Sections 01 6000, Product Requirements and 26 0710, Demonstration and Training.

3.06 Adjusting

- A. Adjust drive parameters to assure proper operation of pump system. Obtain performance requirements from installer of driven loads.

3.07 Cleaning

- A. Touch up scratched or marred surfaces to match original finish.

3.08 Demonstration

- A. Provide systems demonstration under provisions of Section 26 0710, Demonstration and Training.
- B. Demonstrate operation of controllers in automatic and manual modes.

3.09 Training

- A. CONTRACTOR shall provide a training session for up to three (3) OWNER's personnel for one (1) normal working day at a job site location determined by OWNER.
- B. Training shall be conducted by a manufacturer's qualified representative.
- C. Training program shall consist of instructions on the proper maintenance and operation of the equipment.

End of Section

Division 31
Earthwork

Section 31 1100 Clearing and Grubbing

Part 1 General

1.01 Scope of Work

- A. This section includes all clearing and grubbing work indicated on the Plans and as required, complete with cutting and removal of trees, shrubs, vegetation, stumps, logs, brush, roots and undergrowth, and disposal of materials.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200: Unit Prices
- B. Section 01 5713: Temporary Erosion and Sediment Control
- C. Section 01 8900: Site Construction Performance Requirements
- D. Section 31 2200: Grading
- E. Section 31 2313: Subgrade Preparation

1.03 Soil Erosion and Sedimentation Control

- A. CONTRACTOR, at his expense, shall provide, maintain and remove such temporary and/or permanent soil erosion and sedimentation control measures as specified on the Plans or as determined by ENGINEER.
- B. Measures shall prevent surface runoff from carrying excavated materials into the waterways, to reduce erosion of the slopes, and to prevent silting in of waterways downstream of the Work.
- C. Measures should include provisions to reduce erosions by the wind of all areas stripped of vegetation, including material stockpiles.
- D. Comply with requirements of Section 01 5713, Temporary Erosion and Sediment Control.

Part 2 Products (Not Used)

Part 3 Execution

3.01 Clearing

- A. Trees, stumps, brush, hedges, and other vegetation occurring within the contract limits as defined on the Plans or as directed by ENGINEER shall be cut off flush with the ground and shall be completely removed.

3.02 Clearing and Grubbing

- A. Trees, stumps, brush, shrubs, hedges, roots, corduroy, logs, matted roots, other vegetation and debris occurring within the contract limits as defined on the Plans or as directed by ENGINEER, shall be completely removed. Depth of removal shall be in accordance with Article 3.04 or 3.05.

- B. Selective clearing shall consist of removing and disposing of dead, diseased, poorly formed, or otherwise undesirable trees, undergrowth, stumps, uprooted trees and debris. Trees to be removed will be marked and the area where the undergrowth is to be removed will be indicated on the Plans or designated by ENGINEER.

- 1. Selective Clearing, Type I:

- a. Trees and stumps shall be cut off at an elevation not more than four (4) inches (100 mm) above the existing ground level.

- 2. Selective Clearing, Type II:

- a. Trees and stumps shall be chipped or ground down to an elevation approximately four (4) inches (100 mm) below proposed ground level.

3.03 Depth of Removal in Excavation Area

- A. For excavation areas within roadways, parking lots, and other paved areas, the trees, stumps, and roots shall be removed to a depth of not less than 12 inches (300 mm) below the subgrade elevation.
- B. In all other excavation areas, the trees, stumps, and roots shall be removed to a depth of not less than 12 inches (300 mm) below the finish surface elevation, or as indicated on the Plans or as designated by ENGINEER.

3.04 Depth of Removal in Embankment Areas

- A. Within embankment areas for roadways, parking lots, and other paved areas where the top of road material is five (5) feet (1.5 m) or less in height above the existing ground, the trees, stumps, and roots shall be removed to a depth of not less than 12 inches (300 mm) below the existing ground.
- B. Within embankment areas for roadways, parking lots, and other paved areas where the top of road material is more than five (5) feet (1.5 m) in height above existing ground, the trees and stumps shall be cut off flush with the existing ground surface.
- C. For embankment areas other than roadways, parking lots, and other paved areas, the trees and stumps shall be cut off flush with the existing ground surface, or as indicated on the Plans or as designated by ENGINEER.

3.05 Removal of Trees, Stumps, and Other Vegetation

- A. Where trees cannot be felled without danger to traffic or injury to other trees, structures or property, they shall be cut down in sections.
- B. Removal of stumps and roots may be accomplished by the use of a shredding machine meeting the approval of ENGINEER.

3.06 Removing Corduroy

- A. Logs, stumps, poles, brush, and other unsatisfactory material occurring in the contract limits at or below the surface of the ground and within the depth of four (4) feet (1.2 m) below the proposed plan grade shall be removed and shall be disposed of by the CONTRACTOR.

- B. When material is disposed of outside of the contract limits, disposal shall be as specified in Section 01 8900, Site Construction Performance Requirements.
- C. Burial of trees, stumps and other vegetation, will not be permitted, except at disposal areas indicated on the Plans or as determined by ENGINEER. Trees and stumps buried in these areas shall have a minimum cover of two (2) feet (0.6 m).

3.07 Holes and Trenches

- A. Holes and trenches remaining after the clearing or grubbing operations in embankment areas, shall have the sides broken down or leveled, and shall be refilled with acceptable material.
 - 1. Material shall be moistened and properly compacted in layers by tampers or rollers to the density required under roadways, parking areas, and other special areas, as determined by ENGINEER.
 - 2. The same construction procedure shall be applied to all holes and trenches remaining in excavation areas where the depth of holes exceeds the depth of proposed excavation.

3.08 Salvaging Timber

- A. Trees required to be removed and having a diameter of four (4) inches (100 mm), or more, are classed as merchantable timber. On right-of-way, fee simple, merchantable timber shall become the property of CONTRACTOR, unless otherwise specified in the Contract Documents. When such material is placed outside of the right-of-way, CONTRACTOR shall obtain and provide ENGINEER with written permission from owner of the property on which the timber is to be placed.
- B. Merchantable timber to be removed from areas outside of right-of-ways, fee simple, shall be cut and piled for the use of property owner, except where CONTRACTOR provides ENGINEER with a written agreement from the property owner that he does not desire the salvaged timber. Where the property owner has signed such an agreement, the salvaged timber will become the property of CONTRACTOR.
- C. When such material is placed outside the contract limits, CONTRACTOR shall obtain and provide ENGINEER with written permission from the owner of the property on which the timber is to be placed. Timber from 4 to 12 inches (100 to 300 mm) in diameter may be left in full tree lengths or cut to commercial lengths, at the option of CONTRACTOR. Timber 12 inches (300 mm), or more, in diameter shall be cut into commercial lengths and piled separately from other timber.

End of Section

Section 31 2200 Grading

Part 1 General

1.01 Scope of Work

- A. This Section includes site grading as indicated on the Plans, complete with removing and salvaging topsoil, rough grading, finish grading, adjusting structures, and reconstructing structures.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200: Unit Prices
- B. Section 01 5713: Temporary Erosion and Sediment Control
- C. Section 01 8900: Site Construction Performance Requirements
- D. Section 31 1100: Clearing and Grubbing
- E. Section 31 2313: Subgrade Preparation
- F. Section 31 2316: Structural Excavation and Backfill
- G. Section 32 9219: Seeding
- H. Section 32 9223: Sodding

1.03 Soil Erosion and Sedimentation Control

- A. CONTRACTOR, at his expense, shall provide, maintain and remove such temporary and/or permanent soil erosion and sedimentation control measures as specified on the Plans or as determined by ENGINEER.
- B. Measures shall prevent surface runoff from carrying excavated materials into the waterways, to reduce erosion of the slopes, and to prevent silting in of waterways downstream of the Work.
- C. Measures should include provisions to reduce erosion by the wind of all areas stripped of vegetation, including material stockpiles.
- D. Comply with requirements of Section 01 5713, Temporary Erosion and Sediment Control.

Part 2 Products (Not Used)

Part 3 Execution

3.01 Site Grading

- A. Sites shall be graded as specified on the Plans or as determined by ENGINEER. CONTRACTOR shall carry out the grading operation to prevent standing water and soil saturation detrimental to structures and improvements.
- B. Provisions shall be made to preserve and protect trees and other vegetation specified on the Plans or determined by ENGINEER as not to be removed.

3.02 Removing and Salvaging Topsoil

- A. Topsoil encountered along the route of the construction shall be pushed back and preserved for use in restoration following completion of the construction.

- B. Topsoil must remain on each given parcel and lot throughout the Project including the existing road right-of-way adjoining the parcel or lot where it existed.
- C. Removal of topsoil from the Project or movement of topsoil from one portion of the Project for use in another portion of the Project will not be allowed.
- D. If there is insufficient working area, the topsoil may be removed, stockpiled and later replaced on the original lot or parcel. CONTRACTOR shall furnish ENGINEER with written permission obtained from the property owner of the property on which the topsoil is to be stockpiled, prior to commencing the stockpiling operation.
- E. Topsoil shall be salvaged in an amount equivalent to the quantity required by the Plans. Topsoil salvaged in excess of that required by the Plans or as required by ENGINEER will be disposed of by CONTRACTOR at his expense.
- F. Before removing topsoil, all vegetation shall be reduced to a height of approximately four inches (100 mm) and all such vegetation and all brush, stones, rocks, and any other objectionable litter or foreign material shall be removed and disposed of before the ground is broken for topsoil removal.
- G. Equipment and methods of operations shall be such as to avoid the lifting of the subsoil. If soil or weather conditions are unsuitable, CONTRACTOR shall cease stripping until stripping can resumed in a suitable manner.
- H. Topsoil shall be removed within the grading limits for cuts and shall be removed to a width and depth specified on the Plans or as determined by ENGINEER.
- I. Topsoil shall be stockpiled within the limits of construction in areas designated on the Plans, or in areas out of the way of construction as determined by CONTRACTOR. Stockpiles shall be located and shaped so as to avoid diversion of storm water runoff, either in or out of the limits of construction, towards buildings, creation of standing water or interference of controlled irrigation. CONTRACTOR shall not place topsoil around trunks and root areas of trees to be preserved.
- J. Topsoil shall be kept separate from other excavated materials that are to be used for embankment and shall be completely removed from any designated area prior to the beginning of regular excavation or placing embankment in the area.
- K. Topsoil stockpiles shall be located as near the original location as possible and no payment will be made for overhaul.
- L. After the completion of construction, the topsoil shall be screened through a 5/8-inch maximum size mesh screen, spread, graded, raked and prepared for seeding or sodding.

3.03 Existing Sand Onsite

- A. In those instances where the construction takes place within private easements, the sand shall not be removed from each parcel or lot. Sand encountered in existing road right-of-way may be used for construction purposes throughout the Project providing it meets the requirements for the material it is intended to be used for.
- B. Removal of sand from the Project will not be allowed, except for the volume displaced by the new construction.

- C. If there is insufficient working area, the sand may be removed, stockpiled and replaced on the original lot or parcel. CONTRACTOR shall furnish ENGINEER with written permission obtained from the property owner of the property on which the sand is to be stockpiled, prior to commencing the stockpiling operations.

3.04 Rough Grading

- A. Site shall be graded as necessary to comply with the Plans or as determined by ENGINEER. The subgrade shall be roughly established by cut or fill, approximately parallel to proposed finished grades and to elevations which allow for thickness of topsoil and installation of site or roadway improvements.
- B. In fill areas all debris shall be removed from the area to be filled. Material detrimental to site improvement shall be removed from the site and acceptably disposed of as specified in Section 01 8900 Site Construction Performance Requirements.
- C. Original ground shall be scarified and benched or otherwise treated to provide adequate bond and to prevent slippage of fill.
- D. Fill material shall be free of debris or other detrimental material and shall have a moisture content within 2 percent of optimum moisture when placed. All fill shall be compacted to a density not less than 95% of the maximum unit weight and placed in layers no less than nine inches (230 mm) and no greater than 15 inches (380 mm). The maximum unit weight shall be determined by ASTM D698, Method B.
- E. If possible, fills or embankments shall be constructed when the ground is frost-free and there is favorable weather. However, if winter grading is necessary, all ice and snow shall be removed from the surface of the ground before the fill or embankment is placed. No frozen material will be allowed in the fill area or in the embankment being constructed. Any frozen material on a partially completed fill shall be removed before placing any more fill. Frozen material shall be stockpiled outside the grading limits until thawed. Thawed material from the stockpiled frozen material may be used in the fill and embankment areas.

3.05 Finish Grading

- A. General:
 - 1. Subgrade shall be smoothed parallel to proposed finished grades and elevations specified on the Plans. The subgrade shall be scarified to assure bond with the topsoil prior to spreading of the topsoil.
 - 2. Topsoil shall be spread uniformly to provide a smooth, even surface at a finish grade specified on the Plans or acceptable to ENGINEER. After spreading, the topsoil shall be compacted lightly as necessary to minimize settlement. Final grades shall not vary more than one-tenth of a foot (30 mm) from the elevations indicated on the Plans.
 - 3. Finished grading shall be done when the ground is frost-free and weather is favorable.
- B. Adjust Structures:
 - 1. Structures to be adjusted shall be as called for on the Plans or as indicated by ENGINEER.

2. Adjustment of structures shall apply where the elevation of the casting is either raised 12 inches (300 mm) or less, or lowered six (6) inches (150 mm) or less.

C. For Rehabilitation/Resurfacing Projects:

1. For structures in existing pavement, the pavement shall be sawcut a minimum of 5-foot by 5-foot unless otherwise shown on the plans.
2. For structures in concrete pavement, the structure shall be adjusted, backfilled and compacted as noted below.
3. Six inches of aggregate base course, unless otherwise noted on the plans, shall be placed below the proposed concrete pavement.
4. In areas of new concrete pavement, the concrete pavement around the structure shall be poured integral with the rest of the pavement.
5. For resurfacing projects, expansion or epoxy anchored hook bolts shall be placed 18-inches on center around the edges of the existing concrete pavement, unless otherwise shown on the plans.
6. Concrete pavement, minimum 8-inches thick, shall be replaced around the structure to the grade of the adjoining concrete pavement.
7. For structures in bituminous pavement, the pavement shall not be sawcut until after the bituminous base or leveling courses have been completed.
8. Structure shall be adjusted, backfilled and compacted as noted below.
9. Six inches of aggregate base course, unless otherwise noted on the plans, shall be placed below the proposed pavement.
10. A minimum of 8-inches of concrete pavement, unless otherwise noted on the plans, shall be placed to the elevation of the adjoining bituminous base or leveling courses.
11. The bituminous wearing course around the structure shall be placed integral with the wearing course on the remainder of the project.

D. For Bituminous Reconstruction or New Construction Projects:

1. Frame and cover on all new and existing structures shall be removed and the structure plated prior to placing the bituminous base or leveling courses.
2. Bituminous base and leveling courses shall be placed over the plated structures.
3. Prior to placing the bituminous wearing course, the bituminous base and leveling courses shall be sawcut a minimum of 5-foot by 5-foot unless otherwise shown on the plans.
4. Structure shall be adjusted, backfilled and compacted as noted below.
5. Six inches of aggregate base course, unless otherwise noted on the plans, shall be placed below the proposed pavement.

6. A minimum of 8-inches of concrete pavement, unless otherwise noted on the plans, shall be placed to the elevation of the adjoining bituminous base course.
7. Bituminous wearing course around the structure shall be placed integral with the wearing course on the remainder of the project.
8. Sawcutting, removal and replacement of concrete and bituminous pavement, and aggregate base course, shall be incidental to the adjusting the structure unless otherwise noted in the Contract Documents.
9. Existing frame and cover shall be carefully removed and stored, and shall be reinstalled on the same structure, unless a new frame and cover are called for on the Plans.
10. Brick courses or concrete adjustment rings shall be removed or installed as necessary to adjust the structure's frame and cover to the proper elevation.
11. Brick or concrete adjustment rings shall be set in mortar or installed as shown on the Plans and as determined by ENGINEER.
12. Outside surface of the new brick or block structures shall receive a masonry plaster coat, a minimum of 1/2 inch (10 mm) thick.
13. Structure shall be properly backfilled with Class II granular material, compacted in place, and meeting the approval of ENGINEER.
14. Flow in the entire system shall be maintained, at CONTRACTOR's expense, while performing any part of the Work. Also, the structure shall be cleaned and all unsuitable material shall be disposed of at CONTRACTOR's expense.

3.06 Reconstruct Structures

A. General:

1. Structures to be reconstructed shall be as called for on the Plans or as determined by ENGINEER.
2. Reconstruction of structures shall apply where the elevation of the casting must be raised in excess of 12 inches (300 mm), lowered in excess of six (6) inches (150 mm), or to rebuild portions of the existing structure which are deteriorated.

B. For Rehabilitation/Resurfacing Projects:

1. For structures in existing pavement, the pavement shall be sawcut a minimum of 5-foot by 5-foot unless otherwise shown on the plans.
2. For structures in concrete pavement, the structure shall be reconstructed, backfilled and compacted as noted below.
3. Six inches of aggregate base course, unless otherwise noted on the plans, shall be placed below the proposed concrete pavement.
4. In areas of new concrete pavement, the concrete pavement around the structure shall be poured integral with the rest of the pavement.

5. For resurfacing projects, expansion or epoxy anchored hook bolts shall be placed 18-inches on center around the edges of the existing concrete pavement, unless otherwise shown on the plans.
6. Concrete pavement, minimum 8-inches thick, shall be replaced around the structure to the grade of the adjoining concrete pavement.
7. For structures in bituminous pavement, the pavement shall not be sawcut until after the bituminous base or leveling courses have been completed.
8. Structure shall be reconstructed, backfilled and compacted as noted below.
9. Six inches of aggregate base course, unless otherwise noted on the plans, shall be placed below the proposed pavement.
10. A minimum of 8-inches of concrete pavement, unless otherwise noted on the plans, shall be placed to the elevation of the adjoining bituminous base or leveling courses.
11. Bituminous wearing course around the structure shall be placed integral with the wearing course on the remainder of the project.

C. For Bituminous Reconstruction or New Construction Projects:

1. Frame and cover on new and existing structures shall be removed and the structure plated prior to placing the bituminous base or leveling courses.
2. Bituminous base and leveling courses shall be placed over the plated structures.
3. Prior to placing the bituminous wearing course, the bituminous base and leveling courses shall be sawcut a minimum of 5-foot by 5-foot unless otherwise shown on the plans.
4. Structure shall be reconstructed, backfilled and compacted as noted below. Six inches of aggregate base course, unless otherwise noted on the plans, shall be placed below the proposed pavement.
5. A minimum of 8-inches of concrete pavement, unless otherwise noted on the plans, shall be placed to the elevation of the adjoining bituminous base course.
6. Bituminous wearing course around the structure shall be placed integral with the wearing course on the remainder of the project.
7. Sawcutting, removal and replacement of concrete and bituminous pavement, and aggregate base course, shall be incidental to the reconstructing the structure unless otherwise noted in the Contract Documents.
8. Existing frame and cover shall be carefully removed and stored, and shall be reinstalled on the same structure unless a new frame and cover are called for on the Plans.
9. Existing corbel entrance sections or precast concrete chimney type entrance shall be removed along with any additional brick courses or precast concrete sections necessary to achieve the amount of reconstruction called for on the Plans or as determined by ENGINEER.

10. The necessary brick work and precast concrete sections shall be installed to meet the design grade.
11. Manhole steps shall be furnished and shall be installed, as necessary, so that maximum spacing is 24-inches (600 mm).
12. Brick or concrete adjustment rings shall be set in mortar or installed as shown on the Plans and as determined by ENGINEER.
13. Outside surface of the new brick or block structures shall receive a masonry plaster coat, a minimum of 1/2 (10 mm) inch thick.
14. Structure shall be properly backfilled with Class II granular material, compacted in place, and meeting the approval of ENGINEER.
15. Flow in the entire system shall be maintained, at CONTRACTOR's expense, while performing any part of the Work.
16. Structure shall be cleaned, and all unsuitable material shall be disposed of at CONTRACTOR's expense.

End of Section

Section 31 2313 Subgrade Preparation

Part 1 General

1.01 Scope of Work

- A. This Section includes preparing subgrade for pavement construction complete with excavation, embankments, proof rolling, subgrade undercut and backfill, subgrade stabilization fabric, subbase, right-of-way ditching, right-of-way restoration, field quality control, and appurtenances.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200: Unit Prices
- B. Section 01 5713: Temporary Erosion and Sediment Control
- C. Section 01 8900: Site Construction Performance Requirements
- D. Section 31 1100: Clearing and Grubbing
- E. Section 31 3500: Slope Protection
- F. Section 31 2319: Dewatering
- G. Section 32 3100: Fences and Gates
- H. Section 32 9219: Seeding
- I. Section 32 9223: Sodding
- J. Section 32 9000: Plants
- K. Section 34 7113: Guardrails

1.03 Reference Standards

- A. Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. ASTM - ASTM International
 - 2. AASHTO - American Association of State Highways and Transportation Officials
 - 3. MDOT - Michigan Department of Transportation, Standard Specifications for Construction, latest edition

1.04 Allowable Tolerances

- A. Finish subgrade surface shall be shaped to conform to plan grade and cross section within a tolerance of one-inch (25 mm) in ten (10) feet (3.0 m).

1.05 Submittals

- A. Test Reports:
 - 1. Testing lab shall provide ENGINEER with two (2) certified copies of the sieve analysis of the backfill material.
 - 2. Testing of the material and the certification of the test results shall be performed by a testing laboratory approved by ENGINEER.

3. Testing lab shall provide ENGINEER with two (2) certified copies of the compaction and moisture tests of the backfill and subgrade materials.
 4. Testing of the materials and the certification of the test results shall be performed by a testing laboratory approved by the ENGINEER.
- B. Samples:
1. Submit sample of the proposed subgrade stabilization fabric measuring not less than 1 yd² (1 m²) in area, and the manufacturer's certification that the proposed fabric meets or exceeds all requirements listed in Article 2.03 of this Section.
 2. Submissions shall be made not later than 10 working days prior to any installation.

1.06 Product Delivery Storage and Handling

- A. Geotextile fabric shall be furnished and stored in a wrap that will protect the geotextile from ultraviolet radiation and abrasion.
- B. Geotextile shall be covered with the aggregate base as per plan within two (2) weeks of its placement.

1.07 Soil Erosion and Sedimentation Control

- A. CONTRACTOR shall provide, maintain and remove such temporary and/or permanent soil erosion and sedimentation control measures as specified on the Plans or as determined by ENGINEER.
- B. Measures shall prevent surface runoff from carrying excavated materials into the drain, to reduce erosion of the slopes, and to prevent silting in of drain downstream of the Work.
- C. Measures should include provisions to reduce erosions by the wind of all areas stripped of vegetation, including material stockpiles.
- D. Comply with requirements of Section 01 5713, Temporary Erosion and Sediment Control.

Part 2 Products

2.01 Granular Materials

- A. Granular material gradation shall conform to the grading requirements for granular material Class II as specified in MDOT, Section 902.08.

2.02 Aggregate Materials

- A. Aggregate materials, used for undercut backfill shall be crushed limestone, natural aggregate, blast furnace slag, or crushed concrete, meeting the requirements of 21AA, 21A or 22A as specified in MDOT Section 902.06.
- B. Crushed concrete shall be free of all steel and other deleterious materials.

2.03 Subgrade Stabilization Fabric

- A. Subgrade stabilization fabric shall be composed of synthetic fibers formed into a woven fabric. The fibers shall be composed of 85% propylene or ester polymers. The geotextile shall conform to the following requirements listed below:

Property	Test Procedure	Test Result
Grab Tensile	ASTM D4632	270 lbs. (min)
Elongation	ASTM D4632	15% (min)
Trapezoidal Tear	ASTM D4533	100 lbs. (min)
CBR Puncture Strength	ASTM D6241	900 lbs. (min)
Apparent Opening Size	ASTM D4751	40 – 70 U.S. Sieve
Permittivity	ASTM D4491	0.05 per sec (min)

Part 3 Execution

3.01 Removing Structures

- A. Structures and sewers to be removed shall be called for on the Plans or as determined by ENGINEER. Removal or abandonment of structures shall be in accordance with Section 01 8900, Site Construction Performance Requirements.

3.02 Holes

- A. Earth removed during any phase of the excavation or removal operations, resulting in a hole or void, shall be replaced by backfilling to the proposed subgrade with a suitable granular material approved by ENGINEER.
- B. Material shall be compacted to 95% of its maximum unit weight.
- C. Furnishing, placing and compacting of the backfill material shall be at CONTRACTOR's expense.

3.03 Salvaging and Stockpiling Topsoil

- A. Topsoil, within the grading limits for cuts, and where the fill is less than five (5) feet (1.5 m) in height to the top of proposed road, shall be removed to a depth and width specified on the Plans.
- B. Topsoil from peat and muck areas shall not be removed.
- C. Topsoil salvaged in excess of that required by the Plans will be disposed of by the CONTRACTOR at his expense.
- D. Removing and salvaging topsoil shall be in accordance with Section 31 2200, Grading.

3.04 Preparing Roadway Subgrade

- A. Muck, peat and other unsuitable material within the roadway shall be removed, displaced or otherwise treated, as shown on the Plans or as directed by ENGINEER.
- B. Deposits of frost heave material within lines two (2) feet (0.6 m) outside the proposed roadbed shall be removed to a depth of three (3) feet (0.9 m) below the surface of the earth grade, unless otherwise shown on the Plans or as determined by ENGINEER.

- C. Ice and snow shall be removed from the surface of the ground before the embankment is placed.
- D. Muck, peat, frost heave material and other unsuitable material shall be disposed of outside the highway limits or shall be spread uniformly in low places beyond the roadway limits when so approved by ENGINEER.
- E. Old road surfacing or gravel, crushed stone, or other nonrigid type surfacing, occurring within the area of the roadbed and underlying proposed embankment less than 1-foot in depth, and which is not to be salvaged and incorporated in the new Work, shall be plowed or scarified full depth, spread and compacted to form a uniform foundation, before any new embankment is placed.
- F. Old pavement and other rigid structures, occurring within the area of the roadbed and underlying the proposed embankment less than 1-foot in depth and which are not to be incorporated into the new Work, shall be broken up and removed.

3.05 Subgrade

- A. Area to be paved shall be excavated and smoothed to the line, grade and cross section as indicated on the Plans.
- B. Subgrade between the lines two (2) feet (0.6 m) on either side of the proposed edge of pavement or curb shall be compacted to 95% of the maximum unit weight for a depth of seven (7) inches (175 mm), by rolling with a roller weighing not less than ten (10) tons (9000 kg).
- C. Subgrade shall be completed ahead of placing forms or paving a distance equal to the distance of one day's average paving operation. Prior to the paving operation, the subgrade shall be shaped and compacted to the Plan cross section by approved mechanical means.

3.06 Pavement Excavation

- A. Pavement excavation shall consist of all Work required to construct the earth grade and its appurtenances true to the lines, grades, and cross sections called for on the Plans and in accordance with these Specifications.
- B. Excavation shall consist of the following items, any of which or all of which may be included or incidental to it; removing trees, stumps, hedges, roots, culverts, sewers, miscellaneous structures, roadway excavation, removing of all asphalt or concrete pavements, curbs, curb and gutters, sidewalks, end headers, removing aggregate surfaces, salvaging and stockpiling topsoil, subgrade undercut, excavation for structures, trimming and finishing earth grade, fine grading, right-of-way ditching and restoration, and the disposal of all unsuitable material.
- C. Large stones, trees, stumps, brush, shrubs, logs, matted roots, other vegetation and debris occurring between lines three (3) feet (0.9 m) outside the grading limits or as otherwise shown on the Plans shall be completely removed and properly disposed of as specified in Section 31 1100, Clearing and Grubbing.
- D. Earth and other existing materials shall be excavated for the full depth and width of the cross section as shown on the Plans. Material shall be excavated sufficiently for setting of forms or slip-form equipment. Excavation shall be limited to 3,000 linear feet (900 m) of right-of-way unless additional lengths are requested in writing and approved by ENGINEER.

- E. Excess excavated material shall be removed from the project by CONTRACTOR along approved routes to disposal sites approved by OWNER. Disposal of excess excavation and maintenance of the dump sites shall be considered incidental to the price paid for excavation and shall be as specified in Section 01 8900, Site Construction Performance Requirements.

3.07 Borrow Excavation

- A. Materials which are secured from locations outside of the project limits for the purpose of completing embankments and other items, will be considered as borrow excavation.
- B. Borrow pits and the materials to be removed therefrom shall be subject to the inspection of ENGINEER and shall be secured by CONTRACTOR, unless otherwise provided.
- C. Borrow excavation will be measured by volume in cubic yards compacted in place, based on the neat lines called for on the Plans or as authorized by ENGINEER. To facilitate the accurate measurement of borrow quantities, unless otherwise specified in the Contract Documents, CONTRACTOR shall perform all the regular excavation and grading with existing materials for any designated area and ENGINEER will cross section these areas prior to CONTRACTOR furnishing and placing the required borrow material. ENGINEER will then resection the completed area and compute the volume of borrow material in its compacted-in-place state. Any borrow material placed beyond the neat lines called for on the Plans or which is not authorized by ENGINEER in writing will not be measured and computed as borrow excavations. Measurement of borrow material by truck count will not be acceptable.
- D. Public and private roads used by CONTRACTOR between the source of borrow and the Project shall be maintained by CONTRACTOR, at his expense, including repairs of any damage caused by his operations. Also included is the application of a dust palliative when necessary, as determined by ENGINEER.

3.08 Embankments

- A. Embankments shall be constructed with sound earth. Materials shall be deposited and compacted by either the Twelve Inch Layer Method, or the Controlled Density Method. The Controlled Density Method will be required unless the twelve-inch layer method or some other method is specifically called for on the Plans.
- B. Topsoil shall be stripped from the entire fill area. Depth of the topsoil to be removed shall be as shown on the Plans or as determined by ENGINEER. After the topsoil is removed, the entire area upon which the embankment is to be constructed shall be compacted to not less than 90% of the maximum unit weight, to a depth of nine (9) inches (225 mm).
- C. Where stones are prevalent, the material shall be carefully placed so that all large stones will be well distributed, and the crevices completely filled with smaller stones, earth, sand or gravel so as to form a solid embankment. Rock or fragmental material of such size as would prohibit it from being placed in layers of the specified depth shall not be placed in the embankment. In no case shall stones over three (3) inches (75 mm) in diameter be placed within 12 inches (300 mm) of the surface of the earth grade within the areas between lines two (2) feet (0.6 m) outside of the edges of proposed roadbed.
- D. Frozen material shall not be placed in the embankment nor shall embankment be placed upon frozen material.

- E. Construction requirements for the two (2) methods of placing and compacting embankments are as follows:
1. Twelve-Inch Layer Method:
 - a. Material shall be deposited and spread in layers not more than 12 inches (300 mm) in depth, loose measure, parallel to the finished grade and extending to the full width of the embankment. Material shall be deposited by operating the conveying equipment over the layer being placed, insofar as feasible.
 - b. Each layer shall be compacted to not less than 95% of the maximum unit weight as determined at the existing moisture content. Operation of compacting shall be continued until each layer is compacted to the required density for its full width.
 2. Controlled Density Method:
 - a. Material for the embankment shall be deposited and spread in layers not more than nine (9) inches (225 mm) in depth, loose measure, and extending to the full width of the embankment, except that granular material may be spread and compacted in layers not more than 15 inches (375 mm) in thickness if the specified density is obtained.
 - b. Material for embankments of five (5) feet (1.5 m) or less and the bottom four (4) feet (1.2 m) of embankments of more than four (4) feet (1.2 m) above the surface of the ground upon which the embankment is to be constructed shall have not more than the optimum moisture content at the time of compaction.
 - c. Material for that part of the embankment more than five (5) feet (1.5 m) above the surface of the ground upon which the embankment is to be constructed shall have a moisture content of not greater than three (3) percent above optimum at the time of compaction, except that the moisture content of the top three feet (0.9 m) of the embankment shall not exceed optimum. If granular material is used to construct the embankment, it shall be at a moisture content below saturation.
- F. If the material contains an excess of moisture, it shall be dried to the required moisture content before being compacted.
- G. Each layer of material containing the required amount of moisture shall be compacted to not less than 95% of its maximum unit weight, unless otherwise specified, before the succeeding layer is started.
- H. When the original ground upon which the embankment is being placed, or any section of compacted embankment, or the soil in cut sections becomes rutted or distorted by CONTRACTOR's equipment, the method of operation shall be changed to eliminate this condition. CONTRACTOR shall reshape and recompact any areas so rutted or distorted at his own expense. This shall be done before any succeeding layers are placed.

3.09 Rough Grading

- A. CONTRACTOR shall rough grade as close as possible to finished subgrade leaving a minimum to be removed in fine grading.

- B. Excavated material removed during grading and stored along the line of Work between curb and sidewalk on improved lawns shall not be left longer than 48 hours. Lawns or otherwise improved areas shall be left in a neat and clean state within the specified 48 hours.
- C. During the excavation operation, including the placing of the subbase, the Work area shall be kept free of water. A dewatering system shall be provided and maintained by CONTRACTOR at his expense. The dewatering system shall remain in operation until the paving is completed.

3.10 Proof Rolling

- A. After removal of topsoil or other overburden and after construction of embankments, proof roll the existing subgrade with six passes of a minimum 15 ton pneumatic-tired roller. Operate the roller in a systematic manner to assure the number of passes over all areas, and at speeds between 2.5 and 3.5 miles per hour. When proof rolling under structures, one-half of the passes made with the roller shall be in a direction perpendicular to the other passes.
- B. Proof rolling shall be done in the presence of ENGINEER. Rutting or pumping shall indicate unsatisfactory material and that material shall be undercut as determined by ENGINEER and replaced with the appropriate fill material.
- C. Perform proof rolling only when weather conditions permit. Do not proof roll wet or saturated subgrades. Materials degraded by proof rolling a wet or saturated subgrade shall be replaced by CONTRACTOR as determined by ENGINEER at no cost to OWNER. Notify ENGINEER 3 days prior to proof rolling.

3.11 Subgrade Undercut Excavation

- A. Unsuitable subgrade excavation shall be the operation of:
 - 1. removing unsuitable soils as determined by ENGINEER, below the level of the ground after topsoil has been stripped in fill areas where the embankment is to be five (5) feet (1.5 m) or less in height to plan grade, or
 - 2. the removal of unsuitable soils below the subgrade elevation, as determined by ENGINEER in cut areas after the subgrade has been established.
- B. In fill areas, after topsoil has been stripped in accordance with Article 3.03 of this Section, ENGINEER will inspect the embankment area to certify the adequacy of the native soils and to determine the extent of any additional excavation of unsuitable soils prior to placing the first lift of the embankment.
- C. In cut areas after the subgrade elevation has been established by the mass grading operation, ENGINEER will inspect the subgrade to determine the extent of any additional excavation of unsuitable soils.
- D. The areas excavated of unsuitable material, unless otherwise specified in the Contract Documents, shall be backfilled with nonfrost heaving material similar to the adjacent soil. However, in areas as determined by ENGINEER where free water due to seepage is present, the excavation shall be backfilled with Granular Material, Class II, and drainage shall be provided. Backfill shall be compacted to not less than 95% of the maximum unit weight, unless otherwise specified.

3.12 Subgrade Stabilization Fabric

- A. Place Subgrade Stabilization Fabric on prepared subgrade or subbase in the manner and at the location as called for on the plans. Fabric shall be laid smooth and free of tension stress, wrinkles or creases.
- B. Fabric strips shall be placed to provide a minimum overlap of 24 inches (600 mm) for each joint.
- C. Fabric shall be placed so that the upper strip will overlap the next lower strip.
- D. Should the geotextile be damaged during construction, the torn or punctured section shall be repaired by placing a piece of fabric that is sufficiently large to cover the damaged area plus two feet (0.6 m) to adjacent undamaged geotextile in all directions.

3.13 Trimming and Finishing Earth Grade

- A. After the earth grade has been constructed to the required grade, all stones and rocks more than 3 inches (75 mm) in diameter, appearing on the surface of the subgrade shall be removed.
- B. Earth grade and the subgrade shall be trimmed to the grade called for on the Plans. Subgrade, where a subbase or base course is required, shall be trimmed to the established grade within ± 0.1 foot (30 mm). Where a subbase or base course is not required, the subgrade shall be trimmed to the established grade within $\pm 3/4$ inch (20 mm).
- C. Earth grade outside the subgrade shall be trimmed, all irregularities made smooth and the entire site or roadway completed to the required lines, grades, and cross sections. Backslopes and fill slopes shall be finished as either Class A or Class B slopes. Class A slopes shall be required unless otherwise specified in the Contract Documents.
 - 1. Class A Slopes:
 - a. Class A slopes shall be finished to the average slopes shown on the Plans with no variations at any point more than 0.1 foot (30 mm) above or below the established grade measured at right angles to the slopes.
 - 2. Class B Slopes:
 - a. Class B backslopes shall be finished to the average slopes shown on the Plans with no variations at any point more than 0.5 foot (150 mm) above or below the established grade measured at right angles to the slope. The degree of finish of the slopes shall be that obtainable from machine operations. The smoothness of surface finish ordinarily associated with template or string line and hand operations will not be required, but abrupt variations will not be permitted. Debris except sod, leaf mold and rotted forest litter shall be removed and loose clods of earth extending beyond the 0.5-foot (150 mm) tolerance shall be broken or removed.
 - b. Class B fill slopes shall be finished to within 0.2 foot (60 mm) of the established grade and cross section from the outside shoulder line for a distance of three (3) linear feet (0.9 m) down the slope. The remainder of the completed fill slope shall conform to the requirements for Class B backslopes.

- c. Where waste earth or other surplus material is deposited on fill slopes, the slopes may be flattened or otherwise altered as directed by ENGINEER, to produce a uniform cross section which blends with the topography and presents a pleasing appearance.
- D. Where trees or other restrictions do not interfere, the tops of backslopes, bottoms of fill slopes and all other angles in the lines of the cross section shall be rounded to form vertical curves as shown on the Plans or as determined by ENGINEER. Transitions in length of vertical curves shall be gradual and shall present a uniform and attractive appearance. When ditches are constructed in peat, vertical curves may be omitted.

3.14 Subbase

- A. Granular material for subbase shall be evenly spread and compacted as specified in MDOT Section 301.
- B. Thickness of each layer placed shall be determined by the required density obtained but shall not exceed 15 inches (375 mm) in depth, loose measure.
- C. Subbase shall be constructed to the alignment, grade and cross section shown on the Plans. Should the subgrade at any time prior to or during the placing of the subbase become soft or unstable so that rutting occurs in the subgrade, or if the subgrade material is forced up into the subbase material, the operation shall immediately cease and the mixed material shall be removed and disposed of. Subgrade shall be corrected, and new subbase material placed and compacted. This Work shall be considered incidental to the construction of the Project.

3.15 Scarify, Re-Grade and Compact Existing Subgrade

- A. Existing subgrade (base) shall be scarified to a depth of 9-inches to the limits as shown on the plans. Subgrade shall then be re-shaped to the cross section as shown on the plans and compacted. Subgrade shall then be compacted to 95% of the maximum unit weight by rolling with a roller weighing not less than ten (10) tons (9000 kg).

3.16 Roadway Ditching

- A. Ditching shall be constructed at the locations called for on the Plans or as determined by ENGINEER. Ditch may be shaped by "Machine Grading" or another method approved by ENGINEER to achieve the cross section, line and grade shown on the Plans.
- B. Excess material from the ditch construction shall be disposed of by CONTRACTOR at his expense.
- C. Ditch section shall be graded to receive either topsoil and seed or topsoil and sod. Topsoil, seed, sod, fertilizer and mulch shall conform to the requirements specified on the Plans and in Section 32 9219, Seeding or Section 32 9223, Sodding.
- D. CONTRACTOR, at his expense, shall furnish, place and compact any additional material needed to construct the ditch at the location and cross sections called for on the Plans.

3.17 Right-of-Way Restoration

- A. Right-of-way shall be restored in accordance with the type and location specified on the Plans. Right-of-way may be shaped by "Machine Grading" or another method approved by ENGINEER to achieve the cross section, line and grade shown on the Plans.

- B. Excess material from the right-of-way restoration operation shall be disposed of by the CONTRACTOR at his expense, as specified in Section 01 8900, Site Construction Performance Requirements.
- C. Right-of-way shall be graded to receive either topsoil and seed or topsoil and sod. Topsoil, seed, sod, fertilizer and mulch shall conform to the requirements specified on the Plans and in Section 32 9219, Seeding or Section 32 9223, Sodding.
- D. CONTRACTOR, at his expense, shall furnish, place, and compact any additional fill, meeting the approval of ENGINEER, needed to construct the right-of-way to the cross sections called for on the Plans.

3.18 Machine Grading

- A. Work of machine grading shall consist of light grading of such character that, in general, the excavation from ditches and roadbed will be utilized in shaping shoulders and adjacent shallow fills and the work can be performed by a blade grader or similar equipment. Machine grading shall apply on the sections shown on Plans or specified in the Proposal.
- B. Work shall include all necessary scarifying, plowing, discing, moving and shaping the earth to develop the cross section shown on Plans.
- C. Ditches shall be in reasonably close conformity with the line and grade as shown on the Plans or as directed and must drain runoff waters to outlets shown on the Plans or designated by ENGINEER.
- D. Roadbed shall be finished to grade with a blade grader or equivalent equipment.
- E. Intersections, approaches, entrances, and driveways shall be graded as shown or as directed, except that loading and hauling of earth will not be required as part of this Work.

3.19 Maintenance Aggregate

- A. CONTRACTOR shall furnish and install 21A, 21AA or 22A maintenance aggregate to maintain pedestrian and traffic access. Aggregate shall be placed and compacted to maintain access in areas as determined by ENGINEER. Maintenance aggregate will be incidental to the Project unless otherwise specified in the Contract Documents.

3.20 Testing

- A. During the course of the Work, ENGINEER may require testing for compaction, sieve analysis and moisture content of the backfill and subgrade materials.
- B. Taking of samples and the testing required shall be performed by a testing laboratory suitable to OWNER and approved by ENGINEER. Cost for testing and sampling shall be at the expense of OWNER.
- C. ENGINEER shall determine the location and number of samples to be made. The testing laboratory shall furnish the ENGINEER with two (2) certified copies of the results of all tests.
- D. Testing procedures shall conform to current MDOT Standards for Construction.

- E. Maximum unit weight when used as a measure of compaction or density of soils shall be understood to mean the maximum unit weight per cubic foot (or cubic meter) as determined by ASTM D1557, Method D, modified to include all the material passing the 1-inch (25 mm) sieve.

3.21 Defective Work

- A. Any portion of the backfill, subbase or subgrade which is deficient in the specified density shall be corrected by methods meeting the approval of ENGINEER.
- B. Extra testing or sampling required by ENGINEER, because of deficiencies, shall be at CONTRACTOR's expense.

End of Section

Section 31 2316

Structural Excavation and Backfill

Part 1 General

1.01 Scope of Work

- A. This Section includes excavation for structures, removal and disposal of excavated materials, backfilling, backfill materials and compaction.

1.02 Related Work Specified Elsewhere

- A. Section 01 5713: Temporary Erosion and Sediment Control
- B. Section 01 8900: Site Construction Performance Requirements
- C. Section 31 1100: Clearing and Grubbing
- D. Section 31 2200: Grading
- E. Section 31 2319: Dewatering
- F. Section 32 9219: Seeding
- G. Section 32 9223: Sodding
- H. Section 33 1100: Water Utility Distribution Piping
- I. Section 33 3000: Sanitary Utility Sewerage Piping
- J. Section 33 3400: Sanitary Utility Force Mains
- K. Section 33 4100: Storm Utility Drainage Piping

1.03 Reference Standards

- A. Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. ASTM - ASTM International
 - 2. AASHTO - American Association of State Highways and Transportation Officials
 - 3. MDOT - Michigan Department of Transportation, Standard Specifications for Construction, latest edition

1.04 Submittals

- A. Testing laboratory shall provide ENGINEER with two (2) certified copies of the test results of the compaction of the backfill. The testing for compaction and the certification of the test results shall be performed by a testing laboratory approved by ENGINEER.

1.05 Soil Erosion and Sedimentation Control

- A. CONTRACTOR shall provide, maintain and remove such temporary and/or permanent soil erosion and sedimentation control measures as specified on the Plans or as determined by ENGINEER.
- B. Measures shall prevent surface runoff from carrying excavated materials into the waterways, to reduce erosion of the slopes, and to prevent silting in of waterways downstream of the Work.
- C. Measures should include provisions to reduce erosion by the wind of areas stripped of vegetation, including material stockpiles.

- D. Comply with requirements of Section 01 5713, Temporary Erosion and Sediment Control.

Part 2 Products

2.01 Granular Materials

- A. Granular material gradation shall conform to the grading requirements for granular material, Classes I and II, as specified in MDOT, Section 902. Granular material shall be natural bank run sand.

2.02 Coarse Aggregate

- A. Coarse aggregate gradation shall conform to coarse aggregate, 6A, as specified in MDOT, Section 902.

Part 3 Execution

3.01 Dewatering

- A. Area within the vicinity of the new Work shall be dewatered in accordance with Section 31 2319, Dewatering prior to the excavation operation.
- B. Depth of the dewatering shall be sufficient to allow the excavation to remain in a dry condition during the construction of the structure, including the excavating, backfilling and compacting operations.

3.02 Sheet piling, Shoring, and Bracing

- A. CONTRACTOR shall furnish, place and maintain at all times such sheet piling, shoring, and bracing of the excavated area as may be required for safety of the workmen and for protection of the new Work or adjacent structures, including pavement, curbs, sidewalks, pipelines and conduits next to, or crossing the excavated area, and for the protection and safety of pedestrian and vehicular traffic.
- B. CONTRACTOR shall be responsible for the complete design of all sheet piling, shoring and bracing Work.
- C. The design shall be appropriate for the soil conditions, shall be of such strength, quality, dimension and spacing as to prevent caving or loss of ground or squeezing within the neat lines of the excavation, and shall effectively restrain movement of the adjacent soil.
- D. Prior to installing the sheet piling, shoring or bracing, CONTRACTOR shall submit Plans for this Work to ENGINEER for informational purposes only.
- E. Sheet piling, shoring, and bracing, and excavation shall conform to current federal or state regulations for safety.
- F. Where indicated on the Plans and where necessary in the Work, install and leave sheet piling, shoring, and bracing in place. No extra compensation shall be paid to CONTRACTOR for sheet piling, shoring or bracing left in place unless otherwise indicated in the Proposal.
- G. Supports for pipes, conduits, etc., crossing the excavated area shall conform to the requirements of the owners of such facilities and if necessary, shall be left in place.

- H. Furnishing, placing, maintaining and removing of sheeting, shoring, and bracing materials shall be at CONTRACTOR's expense unless otherwise indicated in the Proposal.
- I. CONTRACTOR shall not remove the sheeting, shoring or bracing until the structure has obtained sufficient strength to support the external loads.
- J. Sheeting, shoring and bracing material shall not come in contact with the structure, but shall be installed so that no concentrated loads or horizontal thrusts are transmitted to the structure.

3.03 Cofferdams

- A. A cofferdam shall consist of the maintenance, installation and removal of a substantially watertight enclosure or a well-point system or similar system, which will permit construction of the substructure, above seal or subfooting, in the dry and without damage to the Work. Alternate methods, where used in lieu of cofferdams, will be permitted by authorization only. Such authorization will be considered only after receipt of a permit from all federal, local or State agencies with jurisdiction for the alternate method.
- B. Stream diversion and earth dikes, where used in lieu of cofferdams or a well-point system will be permitted by authorization only. Such authorization will be considered only after receipt of a permit from all federal, local or State agencies with jurisdiction for such construction.
- C. Interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction of forms and the inspection of their exteriors, and to permit dewatering outside of the forms.
- D. Cofferdams, caissons or cribs which are tilted or moved laterally during the process of sinking shall be righted or enlarged so as to provide the necessary clearance.
- E. Cofferdams shall not be braced to substructure forms. They shall be constructed so as to protect the Work in place against damage from high water and to prevent injury to the foundation by erosion. No timber bracing shall extend into or remain in the finished concrete.
- F. Cofferdams shall be removed in such a manner as not to disturb or mar the finished concrete. When called for on the Plans or where necessary in the Work, cofferdam sheeting shall be left in place.
- G. Furnishing, construction, maintenance and removal of the cofferdams including pumping shall be at CONTRACTOR's expense. If CONTRACTOR elects to use a well-point system or similar system, he shall be responsible for any claims for damages resulting therefrom.

3.04 Excavation

- A. Excavation shall include the site clearing and grubbing, the excavating and disposing of materials encountered, the supporting and protecting of structures and/or utilities encountered above and below the ground surface, and the removal of water from the construction site.
- B. Excavation shall also include the removal of existing structures, as shown on the Plans or as determined by ENGINEER.

- C. Rock excavation, if applicable, shall be performed as a part of the excavation in accordance with specifications contained elsewhere.
- D. CONTRACTOR shall keep the limits of his excavation operations within a reasonable close conformity with the location and grade, of each structure.
- E. Excavated materials shall be temporarily stored in a manner that will not cause damage to trees, shrubs, fences, improvements, utilities, private property or traffic. The excavated materials shall not be placed at such locations that will endanger the banks of the excavation by imposing loads thereon.
- F. Excavation shall be of sufficient size to allow for the construction of the new Work, the placing and compacting of the backfill and for the dewatering operation.
- G. When concrete is to bear on or against an excavated surface other than rock, special care shall be taken not to disturb the surface. The final removal of the foundation material to grade shall not be made until just prior to the placing of the concrete.
- H. Concrete shall not be placed until the depth of the excavation has been checked and the suitability of foundation material has been reviewed by ENGINEER.
- I. Excavated material, determined by ENGINEER as suitable for backfill may be used. All excess materials shall be disposed by CONTRACTOR, at his expense, as specified in Section 01 8900, Site Construction Performance Requirements.
- J. Elevations for the bottom of footings shall be subject to such changes as are necessary to insure a satisfactory foundation. Any changes required shall be reviewed by ENGINEER prior to making the change.
- K. Surface of all rock or other hard material upon which concrete is to be placed shall be free of all loose fragments, cleaned and cut to a firm surface. The surface shall be level, stepped or serrated, as shown on the Plans.
- L. Unsound material underlying proposed structures shall be removed and replaced with granular material approved by ENGINEER, in layers not exceeding six (6) inches (150 mm) in depth. Each layer shall be compacted to 95% of maximum unit weight unless indicated otherwise on the Plans, or within these specifications.

3.05 Backfill

- A. Backfill material shall be placed only after the new Work and backfill material have been inspected by ENGINEER.
- B. Backfill shall not be placed against any portion of the new Work until the required curing, surface finishing and waterproofing of such portions have been completed. Backfill which will place an unequalized horizontal loading on the new Work shall not be placed until the concrete has attained at least 70% of its design strength. To equalize horizontal loadings, the required backfill around the new Work shall be placed on opposite sides at the same time.
- C. Granular material shall be used for backfilling within three (3) feet (1 m) of manholes, chambers, valve wells, valve boxes, other pipeline structures, footings, piers, abutments, columns, walls, foundations, etc., unless otherwise indicated in the Contract Documents.

- D. Spaces excavated and not occupied by the new Work or by the specified backfill material, shall be backfilled with suitable material from the excavation.
- E. After the backfill has been placed and compacted to the flow line elevation of any weep holes indicated on the Plans, the back end of each weep hole shall be covered with not less than two (2) cubic feet (0.5 m³) of coarse aggregate.
- F. Large stones, boulders, broken rocks, concrete, and masonry shall not be used in the backfill.
- G. Backfill shall be carried up to the surface of the adjacent ground or to the elevation of the proposed earth grade, and its top surface shall be neatly graded. Fills around all new Work shall be trimmed to the lines shown on the Plans or as directed by ENGINEER.

3.06 Compacting Backfill

- A. Backfill behind and around the new Work shall be placed in layers not more than nine (9) inches in depth and shall be compacted to not less than 95% of the maximum unit weight.
- B. Areas where the density does not affect the construction, as determined by ENGINEER, shall be compacted to not less than 90% of maximum unit weight.
- C. Backfill material shall be placed as specified in MDOT, Section 206.03.B, except for the following modifications. Backfill material shall have a moisture content not greater than three (3) percent above optimum, at the time of compaction. If the material contains an excess of moisture, it shall be dried to the required moisture content before being installed.
- D. Each layer of material containing the required amount of moisture shall be compacted to not less than 95% of the maximum unit weight, unless otherwise specified on the Plans or authorized by ENGINEER, before the succeeding layer is started.
- E. Compaction of the backfill will not be paid for separately, but shall be considered incidental to the Work of backfilling and shall include all the Work of manipulating the soil to obtain the specified densities. No additional compensation will be allowed for any delay required to obtain the specified moisture content or the specified density.

3.07 Cleanup

- A. Immediately following the placing and compacting of the backfill, the excess material shall be removed and disposed of by CONTRACTOR, at his expense, as specified in Section 01 8900, Site Construction Performance Requirements.
- B. Construction area shall be graded and left in a neat, workmanlike condition.
- C. At a seasonally correct time, the disturbed area shall be raked, having topsoil placed thereon, fertilized and restored per the requirements of Section 32 9219, Seeding, or Section 32 9223, Sodding.

3.08 Testing

- A. During the course of the Work, ENGINEER may require testing for compaction or density of the backfill. The taking of samples and the testing required shall be performed by a testing laboratory approved by ENGINEER. The cost for testing and sampling shall be at the expense of OWNER.

- B. Testing laboratory shall furnish ENGINEER with two (2) certified copies of the results of all tests. Testing procedures shall conform to current MDOT, Standards for Construction.
- C. Maximum unit weight, when used as a measure of compaction or density of soils, shall be understood to mean the maximum unit weight per cubic foot or per cubic meter as determined by ASTM D1557, Method A, for granular materials conforming to MDOT, Class I, and Method D, for granular materials and all other soils.

3.09 Defective Work

- A. Any portion of the backfill which is deficient in the specified density shall be corrected by the methods meeting the approval of ENGINEER. Extra testing or sampling required because of apparent deficiencies shall be at CONTRACTOR's expense.

End of Section

Section 31 2319 Dewatering

Part 1 General

1.01 Scope of Work

- A. This Section includes all dewatering work complete with design of dewatering systems, construction and operation of dewatering systems, abandonment of dewatering systems, protection of personnel and structures, environmental protection and restoration.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200: Unit Prices
- B. Section 01 5713: Temporary Erosion and Sediment Control
- C. Section 01 8900: Site Construction Performance Requirements
- D. Section 31 2316: Structural Excavation and Backfill
- E. Section 31 2333: Trenching and Backfilling
- F. Section 03 3000: Cast-In-Place Concrete

1.03 Design of Dewatering Construction

- A. Geotechnical Investigations made in relation to this Project are provided as reference documents. Interpretation of data and reports, performing additional investigations, and obtaining additional data for construction purposes is the responsibility of CONTRACTOR.
- B. CONTRACTOR shall be responsible for the complete design of structures and methods proposed for dewatering the project site, including the implementation of materials, tools and equipment proposed for use in the Work. Temporary wiring associated with the dewatering shall comply with applicable portions of the National Electrical Code.
- C. Provide monitoring wells as necessary to determine the groundwater levels along the alignment and shaft locations.

1.04 Soil Erosion and Sedimentation Control

- A. Dewatering systems design and construction shall conform to the provisions of Part 91 Soil Erosion and Sedimentation Control, of Act 451 "Natural Resources and Environmental Protection Act" PA 451 of 1994; and Section 01 5713, Temporary Erosion and Sediment Control. Where applicable, CONTRACTOR shall obtain and pay for permits and inspections for dewatering construction in accordance with the provisions of PA 451, State of Michigan, 1994, and local government agencies having jurisdiction. No additional claim for compensation shall be allowed because of CONTRACTOR's failure to obtain or pay for such permits and inspections.
- B. CONTRACTOR, at his expense, shall provide, maintain and remove such temporary and/or permanent soil erosion and sedimentation control measures as specified on the Plans or as determined by ENGINEER. The measures shall prevent surface runoff from carrying excavated materials into the waterways, to reduce erosion of the slopes, and to prevent silting in of waterways downstream of the Work. Also, the measures should include provisions to reduce erosion by the wind of areas stripped of vegetation, including material stockpiles.

1.05 Federal, State, and Local Regulations

- A. Dewatering operations shall conform to the requirements of all federal, state, and local agencies having jurisdiction.
- B. Dewatering water discharged to streams, drains or sewers may require permits from federal, state or local agencies having jurisdiction. CONTRACTOR shall comply with all water quality requirements prior to discharging dewatering water. CONTRACTOR shall be responsible for testing and treatment required to meet water quality requirements prior to discharge. No discharges to sanitary sewers will be allowed without prior approval of local agencies with jurisdiction for the sanitary sewers.

1.06 Protection

- A. Take steps necessary, during the Work of this Section, to protect surrounding property and adjacent buildings, private water supplies, roads, drains, sewers, structures and appurtenances. Adequate measures shall be taken to protect such property and construction from the effects of the dewatering operations.

1.07 Submittals

- A. Submit detailed plans indicating proposed type and location of dewatering wells, type and location of collection/conveyance piping, and point of disposal of pumped water. Do not begin any dewatering work until submittals and supporting data have been reviewed by ENGINEER.
- B. Dewatering system shall be designed by a professional with a minimum of seven years documented experience in the installation and design of dewatering systems. Submittal shall be signed and sealed by a registered professional engineer, stating that the proposed dewatering method is adequate to perform the required tasks.

Part 2 Products (Not Used)

Part 3 Execution

3.01 General

- A. Provide electrical power from local utility. Provide stand-by power and any other required auxiliary dewatering equipment to assure continuous dewatering capability. Dewatering, where required, shall be continuous. Dewatering will not be stopped during work stoppage without approval of ENGINEER. Coordinate construction operations to minimize duration and extent of dewatering required.
- B. Dewatering wells are to use properly designed filters to prevent the migration of soil fines into the well.

3.02 Monitoring and Control

- A. During dewatering operations, monitor ground water level with piezometers to ensure the design or specified groundwater elevation is maintained. Install monitoring wells with screens below the excavation level as required. Install wells at minimum 200-foot intervals located between dewatering wells. Provide access to monitoring wells by ENGINEER.

- B. Modify dewatering operation if geotechnical instrumentation or survey measurements indicate movement of structures, sheeting or embankments, or inability to lower groundwater as specified.
- C. Inspect wells and lines on a daily basis to ensure integrity and watertightness. Keep fittings and connections watertight to ensure release of sulfide to atmosphere from groundwater does not occur.

3.03 Existing Drainage Conditions

- A. Prior to beginning any work, verify in the field the location, type and capacity of existing drainage facilities and conditions which will affect the Work of this Section. No allowances shall be made for conditions found during the progress of the dewatering operations because of CONTRACTOR'S failure to verify such conditions.

3.04 Existing Structures and Utilities

- A. CONTRACTOR shall make field verification of all existing structures and utilities at the site of the Work which are scheduled to remain and which may be affected by the Work of this Section. CONTRACTOR shall be responsible for any damage to existing structures and/or utilities caused because of his Work and shall repair such damage at his expense to the satisfaction of ENGINEER or utility owner.

3.05 Drainage of Excavations

- A. CONTRACTOR shall maintain all finished excavation Work free of water during the preparation of the subgrade and until the completion of the Work. No ground or surface water shall be discharged into existing sanitary sewer. No unit of Work shall be constructed under water except as otherwise determined by ENGINEER. Provide and maintain adequate dewatering equipment to remove and dispose of surface or groundwater entering excavations, trenches or other parts of the Work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the construction is complete.
- B. Excavations which extend down to or below the static groundwater elevation shall be dewatered by lowering and maintaining the groundwater level beneath such excavations a distance of not less than 12 inches (300 mm) below the bottom of the excavation. Drainage system methods shall not cause damage to wells or adjacent property. Outlet drainage piping and conduit shall be kept clean and free from sediment. CONTRACTOR shall be held responsible for the condition of all existing pipes, conduits and structures which he may use for drainage.

3.06 Dewatering Sumps and Pump Wells

- A. Sumps and pump wells used as a part of the dewatering system shall be strongly sheathed and braced to protect the construction while in use. Tops of well casings must be covered to prevent animals and debris from entering and shall be 2 to 3 feet (0.6 to 0.9 m) above ground. Sumps and wells, when abandoned, shall be backfilled and compacted to the satisfaction of ENGINEER.

3.07 Drilling

- A. Methods used in drilling wells associated with dewatering systems shall be the responsibility of CONTRACTOR and shall be acceptable to ENGINEER.

- B. Drilling methods shall insure proper placement of well materials and shall not involve displacement of earth formations.
- C. Drilling shall be done with first class equipment of proper type and in good condition, acceptable to ENGINEER.

3.08 Pumping

- A. Equipment for pumping and pumping methods associated with dewatering systems shall be the responsibility of the CONTRACTOR and shall be acceptable to ENGINEER. CONTRACTOR shall construct or furnish adequate discharge piping to conduct and dispose of the water so as to prevent damage to existing structures or property. Pumping equipment shall be first class, acceptable to ENGINEER, of proper type and size for the Work and in good condition. Provide anchors and supports for pumping equipment.

3.09 Filling and Grading

- A. Upon completion of dewatering Work for the Project, abandon and/or fill holes, trenches, ditches and other earth excavations created by the Work of this Section and not scheduled to remain. Do filling, backfilling and grading to restore excavations and earth banks to the lines and levels indicated on the Plans and as determined by ENGINEER. Earth fills shall be compacted to a density equal to that of the surrounding undisturbed earth.

End of Section

Section 31 2333 Trenching and Backfilling

Part 1 General

1.01 Scope of Work

- A. This Section includes open trench construction for utility installation, complete with trenching, sheeting, bracing, bedding, bedding materials, backfilling, backfill materials, and compaction.

1.02 Related Work Specified Elsewhere

- A. Section 01 5713: Temporary Erosion and Sediment Control
- B. Section 01 8900: Site Construction Performance Requirements
- C. Section 31 1100: Clearing and Grubbing
- D. Section 31 2200: Grading
- E. Section 31 2316: Structural Excavation and Backfill
- F. Section 33 1100: Water Utility Distribution Piping
- G. Section 33 3000: Sanitary Utility Sewerage Piping
- H. Section 33 3400: Sanitary Utility Force Mains
- I. Section 33 4100: Storm Utility Drainage Piping

1.03 Reference Standards

- A. Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. ASTM - ASTM International
 - 2. AASHTO - American Association of State Highways and Transportation Officials
 - 3. MDOT - Michigan Department of Transportation, Standard Specifications for Construction, latest edition

1.04 Test Reports

- A. Testing laboratory shall provide ENGINEER with two (2) certified copies of the test results of the compaction of the backfill.
- B. Testing for compaction and the certification of the test results shall be performed by a testing laboratory approved by ENGINEER.

1.05 Mix Design

- A. Submit mix designs for any concrete or flowable fill mixtures to be used on the Project. Include certified test results for seven day and 28 day strengths, together with any technical information for admixtures.

1.06 Soil Erosion and Sedimentation Control

- A. CONTRACTOR, at his expense, shall provide, maintain and remove such temporary and/or permanent soil erosion and sedimentation control measures as specified on the Plans or as determined by ENGINEER.

- B. Measures shall prevent surface runoff from carrying excavated materials into the drain, to reduce erosion of the slopes, and to prevent silting in of drain downstream of the Work.
- C. Measures should include provisions to reduce erosions by the wind of all areas stripped of vegetation, including material stockpiles.
- D. Comply with requirements of Section 01 5713, Temporary Erosion and Sediment Control.

Part 2 Products

2.01 Class II Granular Materials

- A. Class II granular material gradation shall conform to the grading requirements for granular material Class II, as specified in MDOT, Section 902 except as follows. Class II granular material shall be natural bank run sand with a maximum size of 1½-inches (38 mm).

2.02 Crushed Stone Bedding

- A. Crushed, angular, natural stone material, meeting the requirements of MDOT 21AA. Crushed concrete and slag are not allowed.

2.03 Concrete

- A. Concrete shall conform to MDOT, Section 701, use grade S3; 3,000 psi (21 MPa) strength; Type I-A cement; 5.5 sacks cement per cubic yard (307 kg/m³); 6A coarse aggregate; 2NS fine aggregate; 6.5% ± 1.5% air content; 3-inch (75 mm) maximum slump; no admixtures without ENGINEER's review.

2.04 Flowable Fill for Backfilling

- A. Materials:
 - 1. Fly Ash: Fly Ash shall have a maximum loss on ignition of 12% and meet the other requirements of ASTM C618 (Class F).
 - 2. Water: Water shall meet the requirements of ASTM C94.
 - 3. Cement: ASTM C150 or C595, Type I or IA.
- B. Mixture (Strength 100 - 120 psi, (690 - 825 kPa)):
 - 1. Fly Ash: 2000 lbs/c.y. (1190 kg/m³) min
 - 2. Cement: 70 lbs/c.y. (40 kg/m³) min
 - 3. Water: Sufficient water to produce desired flowability, 700 lbs/c.y. (415kg/m³) ±
- C. Temperature of the flowable fill mix as manufactured and delivered shall be at least 50 degrees Fahrenheit (10 degrees Celsius). Flowable fill can be mixed by pugmill, central concrete mixer, ready mix truck, turbine mixer, or other acceptable equipment or method.

Part 3 Execution

3.01 Dewatering

- A. Area within the vicinity of the trenching operation shall be dewatered in accordance with Section 31 2319, Dewatering prior to the trenching operation.

- B. Depth of the dewatering shall be sufficient to allow the trench excavating operation including backfilling and compacting to proceed in a dry condition.

3.02 Trench Excavation

- A. Open cut trench excavation shall include the site clearing and grubbing, the excavating of all materials encountered, the supporting and protecting of all structures and/or utilities encountered above and below the ground surface, and the removal of water from the construction site.
- B. Trenching operation shall commence at the downstream or outlet end of the new Work and proceed upstream, unless otherwise specified on the Plans or directed by ENGINEER.
- C. Trench shall be excavated in reasonably close conformity with the lines and grades specified on the Plans or as established by ENGINEER.
- D. Excavated materials shall be temporarily stored along the trench in a manner that will not cause damage to trees, shrubs, fences, improvements, utilities, private property, public property or traffic. The excavated materials shall not be placed at such locations that will endanger the trench banks by imposing loads thereon.
- E. Trench shall be of sufficient width to provide adequate working space to permit the installation of the pipe and the compaction of the bedding material under and around the pipe. However, for rigid pipe, the width of the trench from below the pipe bedding to 12 inches (300 mm) above the top of the pipe shall not exceed the following dimensions:

Diameter of Pipe	Width of Trench
6-inch thru 12-inch pipe (150 thru 300 mm)	30 inches wide (750 mm)
15-inch thru 36-inch pipe (375 thru 900 mm)	outside diameter plus 16 inches (400 mm)
42-inch thru 60-inch pipe (1050 thru 1500mm)	outside diameter plus 20 inches (500mm)
over 60-inch pipe (1500mm)	outside diameter plus 24 inches (600 mm)

- F. Support the additional load of the backfill when the maximum trench width as specified for rigid pipe is exceeded, CONTRACTOR shall install, at his expense, concrete encasement which shall completely surround the pipe and shall have a minimum thickness at any point of 1/4 of the outside diameter of the pipe or four (4) inches (100mm), whichever is greater, or at his expense, install another type bedding, approved by ENGINEER. Concrete encasement shall consist of 3,000 psi (21 MPa) strength concrete.
- G. For flexible pipe, the minimum width shall be not less than the greater of either the pipe outside diameter plus 16 in. (400 mm) or the pipe outside diameter times 1.25, plus 12 in. (300 mm). Maximum trench width for flexible pipe shall not exceed the minimum width by more than 6-inches.
- H. To support the additional load of the backfill when the maximum trench width as specified for flexible or semi-rigid pipe is exceeded, CONTRACTOR shall install, at his expense, crushed stone pipe bedding to the full width between undisturbed trench walls or at least 2.5 pipe diameters on each side of the pipe.
- I. When through, CONTRACTOR's construction procedure or because of unsuitable existing ground conditions, it becomes impossible to maintain alignment and grade properly, CONTRACTOR, at his expense, shall excavate below the normal trench bottom grade and shall fill the void with a large size aggregate or 3,000 psi (21 MPa) concrete as approved by

ENGINEER to ensure that the pipe when laid in the proper bedding will maintain correct alignment and proper grade.

- J. Trench excavations, including those for shafts and structures, shall be adequately braced and/or sheeted where necessary to prevent caving or squeezing of the soil.

3.03 Sheeting, Shoring, and Bracing

- A. CONTRACTOR shall furnish, place and maintain at all times such sheeting, shoring, and bracing of the trench and/or shaft as may be required for safety of the workmen and for protection of the new Work or adjacent structures, including pavement, curbs, sidewalks, pipe lines, conduits next to or crossing the trench, and the protection and safety of pedestrian and vehicular traffic.
- B. CONTRACTOR shall be responsible for the complete design of all sheeting, shoring and bracing Work. The design shall be appropriate for the soil conditions, shall be of such strength, quality, dimension and spacing as to prevent caving or loss of ground or squeezing within the neat lines of the excavation, and shall effectively restrain movement of the adjacent soil. Prior to installing the sheeting, shoring or bracing, CONTRACTOR shall submit Plans for this Work to ENGINEER for informational purposes only.
- C. Sheeting, shoring, bracing, and excavation shall conform to the current federal or state regulations for safety.
- D. Where indicated on the Plans and where necessary in the Work, install and leave sheeting, shoring, and bracing in place. No extra compensation shall be paid to CONTRACTOR for sheeting, shoring or bracing left in place.
- E. Supports for pipes, conduits, etc., crossing the trench shall conform to the requirements of the owners of such facilities, and if necessary, shall be left in place.
- F. The furnishing, placing, bracing, maintaining, and removing of sheeting, shoring, and trenching materials shall be at CONTRACTOR's expense. CONTRACTOR shall not remove the trench sheeting, shoring and bracing unless the pipe has been properly bedded, and the trench backfilled to sufficiently support the external loads. Also, the sheeting, shoring, and bracing material shall not come in contact with the pipe, but shall be installed so that no concentrated loads or horizontal thrusts are transmitted to the pipe.

3.04 Pipe Bedding

- A. Install and compact in six-inch layers. Particular care shall be taken to assure filling and tamping all spaces under, around, and above the top of the pipe. Work in and around pipe by hand to provide uniform support.
- B. Rigid Pipe Bedding:
 - 1. Rigid pipe bedding shall conform to ASTM C12, except as noted.
 - a. Class R-A:
 - (1) Pipe shall be bedded in crushed stone bedding material placed on the trench bottom. Bedding shall have a minimum thickness beneath the pipe of four (4) inches (100 mm) or 1/4 of the outside diameter of the pipe, whichever is greater, and shall extend up the

sides of the pipe to the horizontal centerline. The top half of the pipe shall be covered with a monolithic plain concrete arch having a thickness of at least four (4) inches (100 mm) or 1/4 of the inside diameter of the pipe, whichever is greater, at the pipe crown and a minimum width equal to the outside diameter of the pipe plus eight (8) inches (200 mm) or 1-1/4 of the diameter of the pipe, whichever is greater.

b. Class R-B:

- (1) Pipe shall be bedded in crushed stone bedding material placed on the trench bottom. Bedding shall have a minimum thickness beneath the pipe of four inches (100 mm) or 1/8 of the outside diameter of the pipe, whichever is greater, and shall extend up the sides of the pipe to the horizontal centerline. Backfill from pipe horizontal centerline to a level not less than 12 inches (300 mm) above the top of the pipe shall be Class II granular material. This material shall be placed in 6-inch (150 mm) layers with each layer thoroughly compacted by mechanical means with the finished compacted material a minimum of 12 inches (300 mm) above the top of pipe.

c. Class R-C:

- (1) Pipe shall be bedded in Class II granular material, placed on the trench bottom. Bedding shall have a minimum thickness beneath the pipe of four (4) inches (100 mm) or 1/8 of the outside diameter of the pipe, whichever is greater, and the bedding shall extend to a level not less than 12 inches (300 mm) above the top of the pipe. This material shall be placed in 6-inch (150 mm) layers with each layer thoroughly compacted by mechanical means with the finished compacted material a minimum of 12 inches (300 mm) above the top of pipe.

C. Flexible Pipe Bedding:

1. Flexible pipe bedding shall conform to ASTM D2321, except as noted. Continuous and uniform bedding shall be provided in the trench for all buried pipe.

a. Class F-I:

- (1) Pipe shall be bedded in crushed stone bedding material placed on the trench bottom. Bedding shall have a minimum thickness beneath the pipe of four (4) inches (100 mm), and shall extend up the sides of the pipe until the top of pipe is covered by a minimum thickness of 12 inches (300 mm).
- (2) Where allowable trench widths are exceeded, Class F-I bedding shall be used to the full width between undisturbed trench walls. Concrete cradle bedding shall not be used.

b. Class F-II:

- (1) Pipe shall be bedded in crushed stone bedding material placed on the trench bottom. Bedding shall have a minimum thickness beneath the pipe of four (4) inches (100 mm), or 1/8 of the outside diameter of the pipe, whichever is greater, and shall extend up the sides of the pipe to the horizontal centerline. Backfill from pipe horizontal centerline to a level not less than 12 inches (300 mm) above the top of the pipe shall be Class II granular material. This material shall be placed in 6-inch (150 mm) layers with each layer thoroughly compacted by mechanical means with the finished compacted material a minimum of 12 inches (300 mm) above the top of pipe.
- (2) Where allowable trench widths are exceeded, Class F-I bedding shall be used to the full width between undisturbed trench walls. Concrete cradle bedding shall not be used.

c. Class F-III:

- (1) Pipe shall be bedded in Class II granular material, placed on the trench bottom. Bedding shall have a minimum thickness beneath the pipe of four (4) inches (100 mm) or 1/8 of the outside diameter of the pipe, whichever is greater, and the bedding shall extend to a level not less than 12 inches (300 mm) above the top of the pipe. This material shall be placed in 6-inch (150 mm) layers with each layer thoroughly compacted by mechanical means with the finished compacted material a minimum of 12 inches (300 mm) above the top of the pipe.
- (2) Where allowable trench widths are exceeded, Class F-I bedding shall be used to the full width between undisturbed trench walls. Concrete cradle bedding shall not be used.

3.05 Backfilling Trenches

- A. Backfill material shall be placed on sections of bedded pipes only after such pipe bedding and backfill materials have been approved by ENGINEER.
- B. Trench backfilling shall follow the pipe laying as closely as possible. However, at no time shall the pipe laying in any trench precede backfilling of that trench by more than 100 feet (30 m), unless otherwise directed by ENGINEER.
- C. Backfilling shall not be done in freezing weather except by permission of ENGINEER. Frozen materials shall not be used in trench backfilling.
- D. Following trench backfill specifications are for use in that portion of the trench beyond the scope of the pipe bedding requirements which normally stops at a point 12 inches (300 mm) above the top of pipe.
 1. Backfill material to be placed above pipe bedding shall be free of cinders, ashes, refuse, boulders, roots, stumps, trees, timbers, brush, debris, or other extraneous materials which in the opinion of ENGINEER, are unsuitable.
 2. Rocks or stones having a dimension larger than six (6) inches (150 mm) shall not be placed within three (3) feet (1 m) of the top of the pipe .

3. Large stones may be placed in the remainder of the trench backfill only if well separated and arranged so that no interference with backfill settlement will result.
- E. The type and method of backfilling is dependent on its location and function and shall conform to the following requirements:
1. Trench "A":
 - a. All other trenches shall be backfilled with suitable excavated material placed in uniform layers that can be adequately compacted and tested from the surface of that layer. Each layer shall be thoroughly compacted by approved mechanical methods to a density equivalent to the undisturbed adjacent soil or 90% of its maximum unit weight which ever is less.
 2. Trench "B":
 - a. Trenches under road surfaces, pavement, curb, driveway, sidewalk and where the trench edge is within three (3) feet (1m) of the pavement and as noted on the plans shall be backfilled with natural bank run sand meeting the requirements of Class II granular material, unless otherwise indicated on the Plans. The material shall be placed in uniform layers that can be adequately compacted and tested from the surface of that layer and shall be compacted to 95% of the material's maximum unit weight. Trenches under pavement to be constructed in the near future, as noted or shown on the Plans, shall be backfilled with natural bank run sand, meeting the requirements of Class II granular material, unless otherwise indicated on the Plans, as herein provided.
 - b. Where a pipe is installed under an existing or proposed utility, the backfill between the two shall be natural bank run sand meeting the requirements of Class II granular material, unless otherwise indicated on the Plans, constructed as herein specified.
- F. Unless otherwise specified on the Plans or as directed by ENGINEER, the trench backfill shall be carried to the adjacent existing ground.
- G. Where any backfill or bedding as shown on the plans or specified is to be flowable fill, care shall be used to avoid displacing any pipes or structures due to fluid pressure. Pipes in backfill areas may need to be secured to avoid the bouyancy effect.

3.06 Compacting Trench "B" Backfill

- A. Trench "B" backfill shall be compacted to 95% of the maximum unit weight, unless otherwise specified on the Plans or authorized by ENGINEER.
- B. Compaction of the backfill will not be paid for separately but shall be considered incidental to the Work of backfilling and shall include all the Work of manipulating the soil, to obtain the specified densities. No additional compensation will be allowed for any delay required to obtain the specified moisture content or the specified density.

3.07 Cleanup

- A. Immediately following the placing and compacting of the backfill, the excess material shall be removed and disposed of by CONTRACTOR, at his expense, as specified in Section 01 8900, Site Construction Performance Requirements. The construction area shall be leveled and left in a neat workmanlike condition.
- B. At a seasonally correct time, approved by ENGINEER, the disturbed area shall be raked, having topsoil placed thereon, fertilized and seeded per the requirements of Section 32 9219, Seeding, or sodded in accordance with Section 32 9223, Sodding.

3.08 Field Testing

- A. During the course of the Work, ENGINEER may require testing for compaction or density of the backfill. Taking of samples and the testing required shall be performed by a testing laboratory suitable to OWNER and approved by ENGINEER. The cost for testing and sampling shall be at the expense of OWNER.
- B. Maximum unit weight, when used as a measure of compaction or density of soils, shall be understood to mean the maximum unit weight per cubic foot or per cubic meter as determined by ASTM D1557, Method D.

3.09 Defective Work

- A. Any portion of the trench backfill which is deficient in the specified density shall be corrected by methods meeting the approval of ENGINEER.
- B. Any extra testing or sampling required because of deficiencies shall be at CONTRACTOR's expense.

End of Section

Division 32
Exterior Improvements

Section 32 1123 Aggregate Base Course

Part 1 General

1.01 Scope of Work

- A. This Section includes aggregate base courses complete with aggregate materials constructed in preparation for paving or aggregate surfacing.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200: Unit Prices
- B. Section 01 8900: Site Construction Performance Requirements
- C. Section 31 2313: Subgrade Preparation
- D. Section 32 1216: Bituminous Paving
- E. Section 32 1313: Concrete Paving

1.03 Reference Standards

- A. Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. ASTM - ASTM International
 - 2. AASHTO - American Association of State Highways and Transportation Officials
 - 3. MDOT - Michigan Department of Transportation, Standard Specifications for Construction, latest edition

1.04 Allowable Tolerances

- A. Finished surface shall be shaped to conform to plan grade and cross section within a tolerance of 3/4 inch in ten (10) feet (30 mm per 5 m).

1.05 Test Reports

- A. Testing lab shall provide ENGINEER with two (2) certified copies of the test results of the thickness of the compacted aggregate. Core drilling, testing for thickness and the certification of the test results shall be performed by a testing laboratory approved by ENGINEER.

1.06 Stockpiling Aggregate

- A. Aggregate shall be deposited in stockpiles in such a manner that the material may be removed from the stockpile by methods which will provide aggregate having a uniform gradation.
- B. Stockpiling of aggregate, in excess of four (4) feet (1.2 m) in depth, on the completed subbase or aggregate surface will not be permitted, except with the approval of ENGINEER.

1.07 Environmental Requirements

- A. Comply with the requirements for aggregate base or surfacing installations due to outside ambient air temperatures specified under Article 3.08 of this Section.

Part 2 Products

2.01 Dense-Graded Aggregate

- A. Dense-graded aggregate gradation shall conform to Series 21 and 22, as specified in MDOT, Section 902.

2.02 Calcium Chloride Additives

- A. Calcium chloride additives shall conform to ASTM D98 and as specified in MDOT, Section 903.

2.03 Water

- A. Water used for compaction and dust control shall be reasonably clean and free from substances injurious to the finished product. Water from sources approved by the Michigan State Department of Public Health as potable may be used.

Part 3 Execution

3.01 Excavation Verification

- A. Prior to the placing of any aggregate material, examine the excavation for the grades, lines, and levels required to receive the new Work. Ascertain that all excavation and compacted subgrades or subbases are adequate to receive the new Work. Correct all defects and deficiencies before proceeding with the Work.

3.02 Subgrade Conditions

- A. Prior to the placing of any aggregate material, examine the subgrade or subbase to ascertain that it is adequate to receive the aggregate to be placed. If the subgrade or subbase remains wet after all surface water has been removed, ENGINEER may require the installation of edge drain.

3.03 Existing Improvements

- A. Investigate and verify locations of existing improvements, including structures, to which the new Work will be in contact. Necessary adjustments in line and grade, to align the new Work with the existing improvements must be approved by ENGINEER, prior to any changes.

3.04 Preparation of Subgrade or Subbase

- A. Subgrade or subbase shall be fine graded to the cross section indicated on the Contract Drawings and shall be thoroughly compacted prior to the placing of the aggregate material.

3.05 Installation - General

- A. Width, thickness, and type of aggregate materials shall be indicated on the Contract Drawings or as directed by ENGINEER.
- B. No aggregate material shall be placed until the subgrade, or subbase, or existing aggregate surface has been approved by ENGINEER.

3.06 Installation of Aggregate Base Course

- A. Aggregate base course shall be placed by a mechanical spreader or other approved means, in uniform layers to such a depth that when compacted, the course will have the thickness shown on the Contract Drawings.
- B. Depth of any one layer, when compacted, shall not be more than 8 inches (200 mm). If the required compaction cannot be obtained for the full depth of the aggregate course spread, the thickness of each course shall be reduced or, with the approval of ENGINEER, adequate equipment shall be used to compact the aggregate to the required unit weight.
- C. The subgrade or subbase shall be shaped to the specified crown and grade and maintained in a smooth condition. If hauling equipment causes ruts or holes in the subgrade or subbase, the hauling equipment will not be permitted on the subgrade or subbase but shall be operated on the aggregate base course behind the spreader.
- D. Aggregate shall be compacted to at least 98% of maximum unit weight by the use of approved pneumatic-tired compaction equipment or vibratory compactors.
- E. Optimum moisture content shall be maintained until the prescribed unit weight is obtained and each layer shall be compacted until the maximum unit weight is attained before placing the succeeding layer.
- F. When approved by ENGINEER, additional water may be applied by an approved means, to the aggregate to aid in the compaction and shaping of the material.
- G. Motor graders, trimmers or other approved equipment shall be used to shape the aggregate base course and maintain it until the surface course is placed.
- H. When hauling material over the base course, subbase or subgrade, CONTRACTOR shall limit the weight and speed of his equipment to avoid damage to the subgrade, subbase or aggregate base course. If the subgrade, subbase or aggregate base course becomes rutted due to CONTRACTOR's operation, the subgrade, subbase or base course shall be removed and replaced, acceptable to ENGINEER, at CONTRACTOR's expense.
- I. With the approval of ENGINEER, chloride additives may be used by CONTRACTOR to facilitate his compaction and maintenance of the aggregate surface. Amount and method of combining the chloride additives are at the option of CONTRACTOR and are at his expense.

3.07 Maintenance During Construction

- A. Aggregate base course and aggregate surface shall be continuously maintained in a smooth and firm condition during all phases of the construction operation.
- B. CONTRACTOR, at his expense, shall provide additional materials needed to fill depressions or bind the aggregate.

3.08 Temperature Limitations

- A. Aggregate materials shall not be placed when there are indications that the mixtures may become frozen before the maximum unit weight is obtained.
- B. In no case shall the aggregate be placed on a frozen subgrade or base course unless otherwise directed by ENGINEER.

3.09 Testing

- A. During the course of the Work, ENGINEER may require testing for compaction or density and for thickness of material. Testing and coring required shall be performed by a testing laboratory acceptable to OWNER and approved by ENGINEER. Cost for testing and coring shall be at the expense of OWNER.
- B. When thickness tests are done, a minimum of one depth (thickness) measurement will be made every 400 linear feet (120 m) per traffic lane. Lane width shall be as indicated on the Contract Drawings or as determined by ENGINEER.
 - 1. If 2 lanes are constructed simultaneously, only one test is necessary to represent both lanes.
 - 2. For areas such as intersections, entrances, cross-overs, ramps, widening strips, acceleration and deceleration lane, at least one depth measurement will be taken for each 1,200 square yards (1000 m²) of such areas or fraction thereof.
 - 3. Location of the depth measurement will be at the discretion of ENGINEER.
- C. The maximum unit weight shall be understood to mean the maximum unit weight per cubic foot (or cubic meter) as determined by ASTM D1557, Method D.

3.10 Defective Work

- A. Thickness:
 - 1. Measurements of aggregate base course thickness will be made to the nearest 1/4 inch (5 mm).
 - a. Depths may be 1/2 inch (10 mm) less than the thickness indicated on the Contract Drawings provided that the average of all measurements taken at regular intervals shall be equal to or greater than the specified thickness.
 - b. In determining the average in place thickness, measurements which are more than 1/2 inch (10 mm) in excess of the thickness indicated on the Contract Drawings will be considered as the specified thickness plus 1/2 inch (10 mm).
 - 2. Locations of the depth measurements will be as specified herein unless otherwise directed by ENGINEER. Sections found to be deficient in depth shall be corrected by CONTRACTOR using methods approved by ENGINEER.
- B. Weight:
 - 1. When the aggregate material is measured by weight in Tons (or metric tons), the pay weights for aggregates will be the scale weight of the material, including admixtures, unless the moisture content is more than 6 percent.
 - a. Moisture tests will be made at the start of weighing operations and at any time thereafter when construction operations, weather conditions or any other cause may result in a change in the moisture content of the material.

- b. If the tests indicate a moisture content in excess of six (6) percent, the excess over six (6) percent will be deducted from the scale weight of the aggregate until such time as moisture tests indicate that the moisture content of the material is not more than six (6) percent.

End of Section

Section 32 1216 Bituminous Paving

Part 1 General

1.01 Scope of Work

- A. This Section includes bituminous paving complete with bituminous materials; bituminous mixtures; installation of bituminous base course, bituminous wearing course, and bituminous curbs; construction of bituminous pavement, sidewalks, drive approaches, and tennis courts, cold milling and pulverizing existing pavements.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200: Unit Prices
- B. Section 01 8900: Site Construction Performance Requirements
- C. Section 31 1100: Clearing and Grubbing
- D. Section 31 2313: Subgrade Preparation
- E. Section 32 1123: Aggregate Base Courses
- F. Section 32 1723: Pavement Markings

1.03 Reference Standards

- A. Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. ASTM - ASTM International
 - 2. AASHTO - American Association of State Highways and Transportation Officials
 - 3. MAPA - Michigan Asphalt Paving Association
 - 4. MDOT - Michigan Department of Transportation, Standard Specifications for Construction, latest edition

1.04 Allowable Tolerances

- A. Following the final rolling, the surface will be tested longitudinally using a 10-foot (3 m) straightedge at locations selected by ENGINEER. Variation of the surface from the testing edge of the straightedge between any two (2) contacts with the surface shall at no point exceed the following limits:
 - 1. For Bituminous Base Course Mixtures:
 - a. Multiple Courses:
 - (1) 3/8 inch (9 mm) for top course
 - (2) 3/4 inch (20 mm) for lower courses
 - 2. For Bituminous Surface Course Mixtures:
 - a. Multiple Courses:
 - (1) 1/8 inch (3 mm) for top course
 - (2) 1/4 inch (5 mm) for lower courses

b. Single Course: 1/4 inch (5 mm)

- B. Variations in excess of the specified tolerance shall be corrected as determined by ENGINEER.

1.05 Material Reports

- A. At the request of ENGINEER, CONTRACTOR shall provide ENGINEER with certification that the various materials to be used conform to the ASTM Standards referred to in the Specifications.
- B. CONTRACTOR shall provide ENGINEER, or his authorized representative, with the certified batch plant delivery tickets prior to the placing of the materials.
- C. CONTRACTOR shall supply ENGINEER with a certified job mix design for each type of bituminous mixture used on this Project.

1.06 Test Reports

- A. Testing lab shall provide ENGINEER with two (2) certified copies of the test results of the mix design and the thickness of the bituminous paving material. Core drilling, testing for mix design and thickness, and the certification of the test results shall be performed by a testing laboratory approved by ENGINEER.

1.07 Environmental Requirements

- A. Comply with the requirements for bituminous concrete installation due to outside ambient air temperatures specified under Article 3.22 of this Section.

Part 2 Products

2.01 Blended Aggregate

- A. The blended aggregate shall conform to ASTM D692, D1073; AASHTO M29, and as specified in MDOT, Sections 501 and 902. Aggregates for bituminous mixtures shall conform to the applicable requirements of Table A: Composition of Bituminous Mixtures and Table B: Mix Design Criteria.

2.02 Mineral Filler

- A. The mineral filler gradation shall conform to AASHTO M17 and to mineral filler, 3MF, as specified in MDOT, Section 902.12.

2.03 Anti-Foaming Agents

- A. The anti-foaming agents shall conform to anti-foaming agents, as specified in MDOT, Section 904.

2.04 Asphalt Binder

- A. Asphalt binder for use in production of bituminous mixtures shall Be Performance Graded Asphalt Binder, PG58-28, per MDOT Section 904, unless otherwise indicated on the Plans.

2.05 Liquid Asphalts

- A. Liquid asphalts for use in pavement construction shall conform to ASTM D2026, D2027, and D2028, AASHTO M81 and M82, and as specified in MDOT, Section 904.

2.06 Emulsified Asphalt (Bond Coat)

- A. Emulsified asphalt for use in pavement construction shall conform to ASTM D244, and as specified in MDOT, Section 904.

2.07 Composition of Mixtures

- A. Bituminous mixtures shall be mixed and placed in accordance with applicable requirements specified in MDOT Section 501, except as otherwise specified in this Section.
- B. Blended aggregate used for the bituminous wearing course on this Project shall have an Aggregate Wear Index (AWI) of 260, or higher.
- C. Aggregates, mineral filler (if required), and asphalt binder shall be combined as necessary to produce a mixture proportioned within the master gradation range limits shown in Table A and meeting the uniformity tolerance limits shown in Table C.
- D. Composition limits in Table A are shown in percent by weight, based on the total aggregate, including mineral filler, in the mixture.
- E. Bituminous mixture specified on the Plans or in the Proposal, when tested at optimum asphalt content (determined in accordance with MDOT Procedures Manual for Mix Design Processing), shall meet the requirements for stability, flow, voids in mineral aggregate (VMA), air voids, fines/binder ratio, fine aggregate angularity, L.A. Abrasion loss, and soft particles as specified in Table B, Mix Design Criteria.
- F. Mixtures failing to meet the requirements specified in Table B will be rejected and the CONTRACTOR will be required to submit additional samples of bituminous mixtures until a combination of material is found which will produce a mixture meeting the Table B requirements.
- G. If there is a change in the source of any of the aggregates, a new job-mix formula will be required.
- H. After the job-mix formula is established, the aggregate gradation and the asphalt binder content of the bituminous mixture furnished for the Work shall be maintained within the Range 1 uniformity tolerance limits permitted for the job-mix formula as specified in Table C.
 - 1. If two (2) consecutive aggregate gradations on one (1) sieve, or asphalt binder contents as determined by the field extractions are outside the Range 1 but within the Range 2 uniformity tolerance limits, CONTRACTOR shall suspend all operations. (Work days will be charged during the down time.)
 - 2. Before resuming any production, CONTRACTOR shall make all necessary alterations to the materials or plant so that the job-mix formula can be maintained within the deviations permitted under Table C.

- I. CONTRACTOR shall provide uniformity in the gradations of the aggregates placed in the cold feed bins so that the combination of aggregates produced for the mixture by blending the aggregates from two (2) or more cold feed bins will be uniformly fed by means of adjustable feeders onto a belt supplying the asphalt plant.
 - 1. Feeders shall be equipped with cutoffs which will automatically stop the operations to the asphalt plant at any time the flow of any aggregate fraction is changed so as to affect the uniformity of the finished product.
- J. CONTRACTOR has the option of using hot bins for proportioning the aggregates to meet the specified tolerances.
- K. Aggregate gradation tests will be made on aggregate extracted from samples of bituminous mixture taken from the trucks as directed by ENGINEER. As a general guideline, samples will be taken at initial start of production and at other times when tests indicate that the aggregate gradation is fluctuating, truck samples will be taken at a frequency of one (1) sample per 250 Tons (225 metric tons) of mixture, but not more than four (4) samples per day. During other periods where tests indicate the aggregate gradation is stable, truck samples will be taken at a frequency of one (1) sample per 500 Tons (450 metric tons) of mixture, but no more than two (2) samples per day.
 - 1. Mixtures exceeding the maximum tolerances listed in Range 2 under Table C, or exceeding the maximum limits specified for the master gradation range will be rejected and CONTRACTOR may be required to remove and replace any bituminous pavements which ENGINEER determines were constructed with mixtures in the excess of these tolerances.
 - 2. Exact mixture proportions will be based on composite samples of aggregate and the particular bituminous material called for on the Plans and in the Proposal.

Part 3 Execution

3.01 Excavation

- A. Prior to the installation of any bituminous concrete pavement, examine the excavation for the grades, lines, and levels required to receive the new Work. Ascertain that all excavation and compacted subgrades are adequate to receive the bituminous pavement to be installed. Correct all defects and deficiencies before proceeding with the Work.

3.02 Subgrade and Base Course Conditions

- A. Prior to the installation of any bituminous pavement, examine the subgrade and base course to ascertain that it is adequate to receive the bituminous concrete pavement to be installed. If the subgrade remains wet after all surface water has been removed, ENGINEER may require the installation of edge drain.

3.03 Existing Improvements

- A. Investigate and verify location of existing improvements, including structures, to which the new Work is to be connected. Adjustments in line and grade to align the new Work with the existing improvements must be approved by ENGINEER, prior to any changes.

3.04 Equipment Requirements

A. General:

1. CONTRACTOR shall furnish sufficient equipment for completing the Work in a timely and efficient manner.
2. Equipment shall be on the job site and ready for normal operation before the placing of material is started.
 - a. Equipment shall be in good working order and of sufficient capacity that the operation can be continuous and a rate of production obtained which insures good workmanship, and eliminates overloading of the equipment or frequent interruptions or delays.
 - b. Equipment shall be subject to inspections and testing during construction.
 - c. Equipment shall conform to the requirements as specified in MDOT, Section 501 and as specified herein.

B. Pavers:

1. Paver shall be an approved self-powered machine capable of spreading and finishing the mixture in a uniform layer at the desired thickness and cross section and ready for compaction. The use of any machine in poor mechanical or worn condition, will not be permitted. Paver shall be of such design that the supporting wheels, treads, or other devices ride on the prepared base. The full width of surface being applied shall be screeded by an oscillating or vibrating screed.
2. Paver shall at all times produce a uniformly finished surface, free from tearing or other blemishes that would require hand work. Screed shall be adjustable to provide for tilting to secure the proper drag or compressive action necessary to produce the desired surface texture.
3. Paver shall be equipped with a hopper and an automatic material-depth control device so that each distributing auger and corresponding feeder shall respond automatically to provide for a constant level of mix ahead of the screed unit to the full width of the lane being paved.
4. In order to ensure that adequate material shall be fed to the center portion of the lane being paved, reverse pitch augers or paddles shall be installed at the inside of one or both ends of the auger shafts to force the mix to the middle portion of the lane. If necessary, to prevent segregation of the mix as it drops off the feed conveyor, baffle plates shall be installed at the required location.
5. When extensions are added to the paver, they shall be provided with the same vibrating screed or tamper action as the main unit of the paver, except for paving variable width areas. Extensions shall also be equipped with a continuation of the automatically controlled spreading augers. Screed and extensions shall be provided with an approved method of heat distribution.
6. Unless specified otherwise, bituminous pavers shall be equipped with an automatically controlled and activated screed and strike-off assembly capable of grade reference and transverse slope control. A manufacturer approved grade

referencing attachment, not less than 30 feet (9 m) in length, shall be used for all lower courses and the first lane of the wearing course. After the first lane of the wearing course has been placed, a 10-foot (3 m), or longer, grade referencing attachment may be substituted for constructing subsequent adjacent lanes of wearing course mixture.

7. A self-propelled mechanical spreader capable of maintaining the proper width, depth, and slope without causing segregation of the material, may be used for base courses and for surface courses less than eight (8) feet (2.4 m) in width.
8. When surfacing ramps or shoulders, or when the grade of a concrete gutter or other existing installation must be met, the manner of use of the automatic grade reference and slope control devices shall be determined by ENGINEER.
9. Whenever a breakdown or malfunction of the automatic controls occurs, the equipment may be operated manually for the remainder of the normal working day, provided this method of operation will produce results meeting the specification requirements.

C. Crushing Equipment:

1. Crushing equipment for pulverizing existing bituminous base course shall be an approved rotary reduction machine having positive depth control adjustments in increments of ½ inch (10 mm) and capable of reducing material which is at least six (6) inches (150 mm) in thickness. The machine shall be of a type designed by the manufacturer specifically for reduction in size of pavement material, in place, and be capable of reducing the pavement material to the specified size. Cutting drums shall be enclosed and shall have a sprinkling system around the reduction chamber for pollution control. The rate of forward speed must be positively controlled in order to ensure consistent size of reduced material. The machine must be equipped with an accurate tachometer which is mounted in full view of the operator. Crushing equipment shall meet the approval of ENGINEER.

D. Cold Milling Machine:

1. Cold Milling machine for removing concrete or bituminous surfaces shall be equipped with automatically controlled and activated cutting drums that are capable of grade reference, transverse slope control, and produce a uniformly textured surface. An approved grade referencing attachment, not less than 30 feet (9 m) in length shall be used. Equipment for removing the concrete or bituminous surface shall be capable of accurately removing the surface, in one or more passes, to the required grade and cross section.

E. Joint Heaters:

1. Joint heaters shall be infrared or other approved heaters, equipped with an automatic ignition and extinguishing system to ensure that the heater operates only when the paver is moving. It shall be of sufficient length and heating capacity to adequately soften the edge of the mat. The heater shall be oriented parallel to the joint edge. The bituminous pavement shall not be heated by a direct open flame.

F. Rollers:

1. Steel-wheel rollers shall weight at least eight (8) Tons (7 metric tons) and shall be self-propelled, vibratory or static, tandem rollers or shall be self-propelled static 3-wheel rollers.
 - a. Steel-wheel rollers shall be free from backlash, faulty steering mechanism, or worn king bolts.
 - b. Steering device shall respond readily and permit the roller to be directed on the alignment desired.
 - c. Rollers shall be equipped with wheel sprinklers and scrapers.
 - d. Roller wheels shall be smooth and free from openings or projections which will mark the surface of the pavement.
2. Vibratory rollers shall have a shutoff to deactivate the vibrators when the roller speed is less than 0.5 mph (.8 km/hr) and shall have provisions to lock in the manufacturer's recommended speed, the vibration per minute, and the amplitude of vibration (dynamic force) for the type of bituminous mixture being compacted.
3. Pneumatic-tired roller shall be of the self-propelled type with a total weight, including ballast, not greater than 30 tons (27 metric tons).
 - a. It shall be equipped with a minimum of seven (7) wheels situated on the axles in such a way that the rear group of tires will not follow in the tracks of the forward group, but will be so spaced that a minimum tire path overlap of 1/2 inch (10 mm) is obtained.
 - b. Tires shall be smooth and shall be capable of being inflated to or adapted to achieve a pressure necessary to provide ground-contact pressures of at least 80 pounds per square inch (550 kPa).
 - c. Tire pressures shall not vary by more than five (5) pounds per square inch (35 kPa) between individual tires.
 - d. CONTRACTOR shall furnish a tire gage which shall be available at all times to enable NGINEER to check the tire pressures.
 - e. CONTRACTOR shall furnish ENGINEER charts or tabulations showing the contact areas and the contact pressures for the full range of tire inflation pressures and tire loadings for the type and size roller used.
4. Roller shall be equipped with a mechanism capable of reversing the motion of the roller smoothly. Roller shall be equipped with wheel sprinklers and scrapers or mats.
5. Rollers shall be of sufficient size to compact the bituminous mixture to the required density without tearing, displacing, or cracking the mat.

G. Chip Spreader:

1. Chip spreader shall be self-propelled and shall be equipped with pneumatic tires.
2. Spreader shall be equipped with a screen mounted below the metering gage.

3. Spreader shall be capable of spreading the cover material uniformly at widths of 3 to 12 feet (1 to 3.5 m), or separate spreaders shall be provided for the specific widths required.

- a. Rate of discharge of the spreader shall be adjustable to spread uniform layers of 10 to 50 pounds per square yard (5 to 27 kg/m²).

H. Bituminous Concrete Curbing Machine:

1. Bituminous concrete curbing machine shall be self-propelled and shall be capable of laying and satisfactorily compacting curved and straight-line curb to the cross section specified on the Plans. It shall be equipped with templates for the cross sections required.

3.05 Preparation of Foundations

- A. For bituminous base course mixtures required to be placed directly on the subgrade, the density, grade and cross section shall meet the approval of ENGINEER at the time of placement of any mixture.
- B. Prior to placing any bituminous mixture, the surface of the existing pavement including joints and cracks shall be thoroughly cleaned of all dirt and debris.
- C. Existing structures within the limits of the new Work shall be adjusted as specified in the Plans, or as directed by ENGINEER.

3.06 Preparation of Aggregate Base

- A. Prior to the placing of any prime coats or any bituminous mixtures, the density, grade and cross section of the aggregate base shall meet the approval of the ENGINEER at the time of placement of any material.
- B. Surfaces that have become too wet or too dry shall be reworked to provide the required density.

3.07 Preparation of Existing Pavement

- A. This Work consists of preparation of the existing concrete road for resurfacing. All broken pavement or pavement not bonded to the base pavement, and loose bituminous surfacing or patches shall be removed. All longitudinal and transverse joints and cracks shall be cleaned in accordance with Article 3.14, Joint Cleanout. Butt joints at the end of surfacing sections and at intersections of adjoining streets shall be made in accordance with Article 3.08. Vertical face of the cut shall be maintained true, straight and undamaged until installation of wearing course.

3.08 Butt Joints

- A. If butt joints are specified on the Plans, or by ENGINEER, the old surface shall be cut back for at least five (5) feet (1.5 m) to a depth of at least 1-inch (25 mm), for the full width of the joint. The vertical face of the cut shall be maintained true, straight and undamaged until installation of wearing course.

3.09 Edge Trimming

- A. Trimming and truing the edge of an existing bituminous surface shall be performed as required to give a straight, sharp edge at the proper elevations.
- B. The existing base under the bituminous surface shall be left undisturbed.

3.10 Removing Bituminous Surfacing

- A. When removing an existing bituminous pavement, the edges of the area to be removed shall be cut along straight lines, either perpendicular or parallel to the direction of travel, for the full depth of the bituminous surfacing with the cut edge a minimum of 18 inches (450 mm) back from the disturbed edge of pavement.
- B. The cutting of the edges and the breaking up of the bituminous material within the removal area, and the removing and disposing of the unsuitable material are included in the Work of removing bituminous surfacing.

3.11 Removing Bituminous Patches

- A. Where the removal of bituminous patching material is specified on the Plans or as directed by ENGINEER, it shall be saw cut along the edges of the patched area to prevent the tearing of the adjoining pavement surfaces during the removal operation.
- B. Cutting, removing and disposing of bituminous surfacing and unsuitable materials are included in the Work of removing bituminous patches.

3.12 Pulverization and Shaping of Existing Bituminous Base Course

- A. This Work consists of scarifying, pulverizing, milling, crushing, adding new material if required, shaping, rolling, compacting, and proofrolling the crushed base to the proper elevation and slope.
- B. Additional materials required to fill holes and voids shall be furnished at CONTRACTOR's expense. Additional aggregate, if required shall be 20A or 22A aggregate.
- C. The material shall be scarified and uniformly pulverized to a maximum size of two inches (50 mm), in addition, 95 to 100 percent of the material shall have a particle size of 1-1/2 inches (40 mm) or smaller.
- D. The material shall be scarified and uniformly pulverized, in one or more passes, to the depth specified on the Plans or as determined by ENGINEER.
- E. The maximum length or width of roadbed to be scarified and pulverized at any one time shall be as specified on the Plans or as determined by ENGINEER.
- F. The crushed material shall be rough graded to within 3/4 of an inch (20 mm) of the grade called for on the Plans, or as directed by ENGINEER. Additional aggregate shall be placed, if necessary, to attain the required cross sections.
- G. After the material has been balanced, it shall be thoroughly mixed. In restrictive areas, the material to be mixed may be bladed into a windrow to provide working room for the mixer.

- H. The mixed material shall be shaped and compacted in reasonably close conformity with the lines, grades, and cross sections shown on the Plans or as established by ENGINEER. Excess material shall be removed and disposed of by CONTRACTOR at his expense.
- I. Finished rolling shall be done with a vibratory steel wheel roller.
- J. Aggregate-bituminous pavement mixture shall be compacted to not less than 95 percent of the unit weight obtained by the AASHTO T180 test method. The test shall be made on the aggregate-bituminous mixture at the field moisture content existing during the compacting operation. Required density shall be maintained until the material has been surfaced.
- K. Prior to the placing of any surface courses, the pulverized material shall be proofrolled. Proofrolling shall be accomplished with an 18,000 pound (82 000 kg) single axle load. Unstable areas shall be removed and backfilled.

3.13 Hand Patching

- A. Where the filling of holes and depressions in the base or the replacing of the patches is specified on the Plans or as directed by ENGINEER, the filler material shall be an approved bituminous mixture.
- B. The mixture selected will be dependent on the depth and size of the patch and the type of mixture and performance grade of the asphalt binder required.
- C. Patches shall be compacted to the required grade by use of a machine vibrator or approved roller.

3.14 Joint Cleanout

- A. Where joint cleanout is specified on the Plans or as directed by ENGINEER, the joint sealants and foreign material shall be removed to a minimum depth of 1-inch (25 mm) by approved mechanical or hand methods.
- B. Removal and disposal of unsuitable materials and the removal and disposal of bituminous surface patches adjacent to joints are included in the Work for joint cleanout.

3.15 Repairing Pavement Joints

- A. Where existing pavement joints and cracks are to be repaired, as specified on the Plans or as directed by ENGINEER, the existing bituminous surface and any loose or spalled concrete around the joints and cracks shall be removed.
- B. Each joint or crack shall be cleaned and shall be filled with an approved mixture and the mixture shall be compacted with a vibratory machine or by an approved method.

3.16 Cold Milling Concrete or Bituminous Pavement

- A. Where cold milling concrete or bituminous pavement is specified, the pavement shall be milled to the shape and cross section as shown on the plans. Immediately after cold milling, the surface shall be cleaned. CONTRACTOR shall remove and dispose of any resulting debris.
- B. When allowed by ENGINEER, milling materials may be used for temporary wedging.

1. Prior to placing pavement, temporary wedging materials shall be removed and disposed of.
2. Wedging with milled materials is incidental to the Project.

3.17 General Bituminous Pavement Installation Requirements

- A. The width, thickness and type of bituminous paving improvement shall be specified on the Plans, indicated in the Proposal or as determined by ENGINEER.
- B. At street intersections, curb drops conforming to the current rules and regulations of Act 8, Michigan PA 1973, as amended, shall be provided for the construction of sidewalk ramps. In addition, curb drops for sidewalks and driveway approaches shall be provided in locations called for on the Plans or as determined by ENGINEER.
- C. Existing improvements, including structures, shall be protected to prevent their surfaces from being discolored during application of bituminous materials.

3.18 Bituminous Prime Coat or Bond Coat

- A. The prepared foundation shall be treated with bituminous material for prime coat or bond coat as specified. A bond coat shall be applied to each layer of bituminous mixture before the succeeding layer is placed.
- B. Bituminous material shall be applied uniformly by means of a pressure distributor, and only in such areas as may be inaccessible to the regular distributor operation shall the bituminous material be applied by means of the hand spraying apparatus of the distributor.
 1. Where necessary to accommodate traffic, the surface shall be treated half-width or as recommended by ENGINEER.
 2. Foundation shall be free from moisture when the treatment is applied.
 3. Under no circumstances shall pools of bituminous material be allowed to remain on the surface.
- C. The amount of prime coat to be applied per square yard shall be 0.05 gal/s.y (250 ml/m²) unless otherwise specified on the Plans or recommended by ENGINEER.
- D. When prime coat is applied, the surface course shall not be placed until the prime coat has been properly cured. No blotting of the prime coat with aggregate in lieu of proper curing will be permitted.
- E. Prime coat may be omitted or reduced when authorized by ENGINEER.
- F. Bond coat shall be applied at the rate specified by ENGINEER. This rate will be between 0 and 0.10 gallons per square yard (0 to 450 ml/m²) on the bituminous or concrete foundation and between 0 and 0.05 gallons per square yard (0 to 250 ml/m²) between subsequent courses.
- G. Bond coat material shall be applied ahead of the paving operation for a distance of at least 1,500 feet (450 m), depending on traffic conditions, as determined by ENGINEER. The surfacing shall not be placed until the bond coat has cured.

3.19 Transportation of Mixtures

- A. The transportation of the mixtures as specified shall be in accordance with MDOT, Section 501.

3.20 Placing Bituminous Mixtures

- A. Pavers will be required to have an automatically controlled and activated screed and strike-off assembly except when placing mixtures for:
 - 1. Variable width sections;
 - 2. Sections of pavement less than 1,000 feet(300 m) in length;
 - 3. Placing the first course of a base course mixture on an earth grade or on a sand subbase; or,
 - 4. Placing base course mixtures in widths less than eight (8) feet (2.5 m).
- B. Bituminous base course mixtures shall not be placed in lifts exceeding three (3) inches (75 mm), unless otherwise approved by ENGINEER.
 - 1. Approval to place lifts in excess of three (3) inches (75 mm) will be based on the ability of CONTRACTOR to place and compact the base course to the required cross section and within the specified tolerances.
- C. For lifts of 2-1/2 inches (65 mm) or greater, a berm of shoulder material shall be banked against the outside edge of each layer of mixture placed unless the sequence of operations is such that the edges of the material are adequately confined and supported in some other manner.
 - 1. The width of material placed shall be twice the height of the bituminous layer being placed but in no case less than a 6-inch (150 mm) width.
- D. When the application rate for a bituminous wearing course exceeds 220 pounds per square yard (120 kg/m²), the pavement shall be constructed in two (2) or more courses, unless otherwise specified on the Plans or as authorized by ENGINEER.
- E. Bituminous mixture shall be placed by an approved self-propelled mechanical paver to such a depth that when compacted, it will have the thickness specified.
 - 1. 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 upon the base.
 - 2. The paver speed shall be adjusted at the discretion of ENGINEER to that speed which, in his opinion, gives the best results for the type of paver being used and which coordinates satisfactorily with the rate of delivery of the mixture to the paver to provide a uniform rate of placing the mixture without intermittent operation of the paver.
- F. When delays result in slowing paving operations such that the temperature of the mat immediately behind the screed falls below 170 degrees Fahrenheit (75 degrees Celsius), paving shall be stopped, and a transverse construction joint placed.

- G. Bituminous mixture shall be placed in one (1) or more layers as called for on the Plans or as approved by ENGINEER.
 - 1. To take out irregularities in the existing road surface, wedging with bituminous mixture shall be done by placing several layers with the paver.
 - 2. Corrections to the foundation by wedging with bituminous material shall be made by placing, compacting, and allowing the material to cool prior to paving.
- H. Bituminous mixtures shall be placed using two (2) pavers in echelon or one (1) paver equipped with an approved joint heater.
 - 1. ENGINEER may omit the use of the joint heater if the temperature of the previously placed mat does not fall below 170 degrees Fahrenheit (75 degrees Celsius) prior to placement of the adjacent course.
- I. Echelon paving will be permitted when allowed by ENGINEER.
- J. Cold joints will be permitted along acceleration and deceleration lanes, lanes less than full width, irregularly shaped sections, and at transverse joints.
 - 1. Edges of the initial mat for all cold joints shall be painted with bituminous material before the bituminous mixture is placed in the adjacent section.
 - 2. In placing the bituminous mixture adjacent to all joints, hand raking or brooming will be required to provide a dense smooth connection.
- K. Connections with existing surfaces at the beginning and ending of resurfacing sections and at intersections shall be made by feathering out the mix, by constructing a butt joint, or as approved by ENGINEER.
- L. When placing the bituminous mixture in a lane adjoining a previously placed lane, the mixture shall be placed such that it uniformly overlaps the first lane by two (2) to four (4) inches (50 to 100 mm) and is placed at a height above the cold mat equal to the breakdown roller depression on the hot mat.
 - 1. Overlapping material shall be bumped, back onto the hot lane so that the roller will compress the excess material into the hot side of the joint.
 - 2. If, in the opinion of ENGINEER, the overlap is excessive, the excess material shall be trimmed so as to leave an edge having a uniform thickness.
 - 3. Excess material shall be discarded; it shall not be spread across the surface course.
- M. If the lanes are being constructed with two (2) or more pavers in echelon, the loss depths of bituminous material from each paver shall match at the longitudinal joints.

3.21 Rolling and Compacting of Bituminous Mixtures

- A. Each layer of bituminous mixture shall be compacted with approved rollers. At least two (2) rollers will be required when the mixture lay-down rate exceeds 800 square yards (650 m²) per hour.
- B. Steel 3-wheel rollers may be used for initial compaction immediately following the paver.

- C. The final rolling operation on each layer of bituminous mixture shall be accomplished by use of tandem steel-wheel rollers or by use of vibratory rollers operated in the static mode.
- D. Roller wheels shall be kept properly moistened with water.
- E. Pneumatic-tired rollers shall be operated in a competent manner and shall not mark or rut the surface or displace the pavement edges.
 - 1. Pneumatic-tired roller shall be ballasted to obtain the required ground-contact pressures as directed by ENGINEER.
 - 2. To obtain a uniformly textured mat and the desired pavement density, ENGINEER may recommend CONTRACTOR to raise or lower tire pressures at any time during the rolling operations.
 - 3. Roller operations shall be conducted in such a manner as to prevent scuffing or chatter marks in the pavement surface.
 - 4. The number of passes made by the pneumatic-tired roller shall not be less than two (2) round trip passes over each area.
- F. Rolling of the mixture shall begin as soon after placing without undue displacement, picking up the mat, or cracking.
 - 1. Rolling shall 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.
 - 2. Alternate trips of the roller shall be of slightly different lengths.
 - 3. The maximum roller speed shall not exceed the manufacturer's recommended speed for the type of mixture or thickness of layer being placed.
- G. When compacting an adjoining lane, the longitudinal joint shall be rolled first with the roller supported mainly on the cold lane with only three (3) to six (6) inches (75 to 150 mm) of the roller extending onto the freshly placed bituminous material.
- H. Finish rolling shall continue until all roller marks are eliminated.
- I. Pneumatic-tired rollers will not be permitted on wearing courses.
- J. Areas too narrow to be rolled directly by standard 8-Ton (7 metric ton) tandem rollers shall be compacted by self-propelled trench rollers of suitable width, approved by ENGINEER, and weighting not less than 300 pounds per inch of width (5500 kg/m).
- K. Skin patching on an area that has been rolled will not be permitted. Any mixture that becomes mixed with foreign material or is in any way defective shall be removed and replaced at CONTRACTOR's expense.
- L. See Article 3.31 of this Section for compaction test.

3.22 Weather and Seasonal Limitations

- A. Bituminous mixtures shall not be placed, nor the prime coat or bond coat applied, when rain is threatening or when the moisture on the existing surface would prevent satisfactory bonding.
- B. Unless otherwise approved by ENGINEER in writing, minimum mixture temperature limitations at the time of placement, and seasonal limitations for placing bituminous mixtures shall be in accordance with the following:
- C. Seasonal Limitations:
1. Upper Peninsula..... June 1 - Oct 15
 2. Lower Peninsula, north of M-46..... May 15 - Nov 1
 3. Lower Peninsula, south of M-46..... May 5 - Nov 15

Mix Temperature Placement Limitations:			
Temperature of Surface being Overlayed °F (°C)	Rate of Application of Bituminous Material, lbs/syd (kg/m³)		
	< 120 (65)	120 – 200 (65 – 110)	> 200 (110)
35 – 39 (2 – 4)	-	-	329 (165)
70 – 78 (21 – 25)	302 (150)	289 (142)	275 (135)
79 – 86 (26 – 30)	289 (142)	275 (135)	275 (135)
86 and Over	275 (135)	275 (135)	275 (135)

- D. Bituminous paving will not be allowed below these minimum temperatures, nor when there is frost on the grade or existing surface.

3.23 Heating Bituminous Materials

- A. Bituminous material which requires heating before application shall be heated in such a manner as to insure a uniform temperature throughout the entire mass with efficient and positive control at all times. It shall be heated to a temperature consistent with the type of material used and only to such temperature as will insure the necessary fluidity.
1. Excessively high temperatures shall be avoided.
 2. A thermometer shall be provided to enable ENGINEER to observe the temperature at any time.
 3. Bituminous material which has been overheated will be rejected.
- B. Asphalt emulsion shall be circulated continuously when heated above atmospheric temperature so as to prevent it from separating.
1. Heating of asphalt emulsion to the required temperature for application shall be done entirely in the distributor unless a uniform temperature is maintained in the storage tank by means of a circulating heater.
 2. Asphalt emulsion which has been damaged by continuous heating for too long a time or by alternate heating and cooling will be rejected.

3.24 Patching

- A. Where patching is required on a bituminous surface or concrete surface because of small holes or pitted surface, the holes shall be cleaned of all dirt and foreign material.
- B. The bituminous patching material shall be placed, struck off and compacted so that when completed, the patch shall be flush with the adjacent pavement. The compaction may be done with a hand tamper, vibratory compactor or roller.
- C. When patching is required for repairing a cut in the pavement, made for the construction of underground structures and utilities, the granular backfill shall be compacted to not less than 95% of the maximum unit weight.

An aggregate base material of not less than 12 inches (300 mm) compacted thickness, or a bituminous base of the specified thickness, shall be used. The top of the base shall be 2 to 2-1/2 inches (50 to 65 mm) below the surface of the adjacent pavement. Bituminous patching material shall be placed and compacted.

- D. The surface of the bituminous patch shall be smooth and shall not vary more than 1/4 inch (5 mm) from the crown and grade of the adjacent pavement. Variations over 1/4 inch (5 mm) from the established grade shall be corrected as determined by ENGINEER.

3.25 Chip Seal

- A. Seal coating shall consist of 1 or more applications of bituminous material applied to the prepared surface and 1 or more coverings of coarse or fine aggregate applied to the bituminous material.
- B. Asphalt Emulsion shall be HFRS-2M or CRS-2M and aggregate shall be MDOT 29A unless otherwise specified on the plans.
- C. Cover materials used for seal coating shall be sufficiently dry when it comes in contact with bituminous material. The moisture content shall not exceed 3 percent by weight, dry basis. Satisfactory means shall be provided for the protection of the coating materials against excessive moisture by covering stockpiles, by aeration or through manipulation.
- D. The bituminous material specified for surface coat shall be uniformly applied by means of the pressure distributor in the number of applications provided and in the amount per square yard as determined by ENGINEER. Each application of bituminous material shall cure sufficiently to prevent displacement or pickup by traffic or construction equipment before a succeeding application of bituminous material is made.
- E. Following the application of surface coat bituminous material, the cover material shall be uniformly spread over the surface by means of approved mechanical spreaders, in the amount per square yard as specified or as determined by ENGINEER. Truck wheels shall ride on spread cover material and not on bituminous material.
- F. Irregularities or deficiencies in the uniformity of the cover aggregate on the surface shall be corrected by hand spreading and dragging.
- G. Following the spreading of each course of cover material, the surface shall be rolled by means of approved rollers.

- H. Rolling shall immediately follow the placing of cover material before the bituminous material has set. At no time shall there be more than 300 feet (90 m) of unrolled cover material. No cover material shall be left unrolled for more than five (5) minutes.
- I. Sufficient rolling shall be done to embed the cover material in the bituminous material without crushing the aggregate.
- J. For areas deficient in cover material after completion of the surface treatment, additional cover material shall be added. For areas with excessive cover material, the excess cover material shall be removed before the next seal is applied. Final application of cover material shall be swept with a power broom.
- K. Completed surface shall be maintained with a drag, broom or other approved equipment to keep the material well distributed on the road until all cover material possible has been embedded in the bituminous material. The length of time required for this maintenance will be from 2 to 5 days, as determined by ENGINEER, depending on the weather and the materials used.

3.26 Bituminous Concrete Curb

- A. Bituminous concrete curb shall be constructed to the design specified on the Plans or as approved by ENGINEER and shall include the conditioning and treating of the surface on which the curb is to be placed.
- B. Materials used in the construction and installation of bituminous concrete curbing shall meet the requirements as specified in Part 2, Products of this Section, and as specified in MDOT, Section 904.
- C. Bituminous concrete curb mixture shall be 13 or 13A as specified in this Section and in accordance with MDOT, Section 501, unless otherwise approved by ENGINEER.
- D. Bituminous curb shall be constructed to conform to the Plans or as determined by ENGINEER. The method of construction shall conform to MDOT, Section 805, unless otherwise specified.
- E. Bituminous mixture shall be thoroughly compacted by a curbing machine to the cross section shown on the Plans, or as determined by ENGINEER. The curb shall be formed to the density to produce a tight surface texture. Curbs showing segregation, slumping, or misalignment shall be removed and replaced at CONTRACTOR's expense.
- F. When specified on the Plans or as directed by ENGINEER, an application of asphalt emulsion or other approved bituminous coating shall be applied to the finished curb at the joint of the curb and pavement, or to the inside face of the curb, or to both, as a protective seal.
- G. Backfilling behind the curb shall not commence until the bituminous mixture has cured.
- H. Backfill material shall be placed and thoroughly tamped and compacted to the satisfaction of ENGINEER, without disturbing the curb, and shall be left in a neat and workmanlike condition.

3.27 Bituminous Approaches, Sidewalks, and Shoulders

- A. This Work shall consist of constructing a bituminous surface course as specified on the Plans, or as approved by ENGINEER. Bituminous surface course shall be placed on a prepared foundation.
- B. Bituminous materials used shall be as specified on the Plans, or as approved by ENGINEER. Materials acceptable for use are specified in Part 2 of this Section, and as specified in MDOT, Section 904.
- C. Bituminous approach mixture shall be in accordance with MDOT, Section 501, unless otherwise approved by ENGINEER.
- D. Existing pavement or aggregate base shall be prepared to receive the bituminous surface course as specified in this Section.
- E. Bituminous prime and bond coats used shall meet the requirements specified in this Section. Care shall be taken to prevent spreading of bituminous material on adjoining surfaces. When approved by ENGINEER, the prime coat may be omitted.
- F. The bituminous mixture shall be placed to the thickness specified on the Plans or as determined by ENGINEER.
- G. Placing the bituminous mixture shall conform to this Section.
- H. When approved by ENGINEER, the paver used for placing bituminous approaches and sidewalks will not be required to have an automatically controlled or activated screed or strike-off assembly or the corresponding grade referencing equipment. Also, with approval from ENGINEER, only one (1) roller may be used with each paver.

3.28 Tennis Courts

- A. Bituminous tennis courts shall be constructed to the cross section shown on the Plans, or as determined by ENGINEER.
- B. Materials used in the construction of the bituminous tennis court shall meet the requirements specified in Part 2 of this Section, and as specified in MDOT, Section 904.
- C. Bituminous base course mixture shall be 13 or 11A as specified in this Section and MDOT, Section 501 unless otherwise specified on the plans.
- D. Bituminous surface course mixture shall be 4C, 13A or 36A as specified in this Section and MDOT Section 502, unless otherwise specified on the plans.
- E. Asphalt content and performance grade shall be determined by the job mix formula submitted by the CONTRACTOR and approved by ENGINEER.
- F. Bituminous base course and wearing course shall be constructed to conform to the Plan. The method of construction shall conform to MDOT Section 502, unless otherwise specified.
- G. Bituminous bond coat used shall meet the requirements specified in this Section.
- H. The rate of application shall be 0.05 - 0.10 gallons per square yard (225 to 450 ml/m²).

- I. For the preparation of the foundation to receive the bituminous base course and bituminous surface course, see the appropriate Articles in Part 3 of this Section.
- J. Bituminous base course, if required, and the bituminous surface course shall be installed to thickness shown on the Plans. The method of installation of mixtures shall conform to this Section.

3.29 Cleanup

- A. Area adjacent to the new Work shall be backfilled with sound earth of topsoil quality.
- B. Backfill shall be compacted, leveled and left in a neat, workmanlike condition. At a seasonally correct time the disturbed area shall be raked, have topsoil placed thereon, fertilized and seeded per the requirements of Section 32 9219, Seeding, or sodded in accordance with Section 32 9223, Sodding.

3.30 Monument Boxes

- A. Government, plat, and street intersection monuments within existing or proposed pavement shall be preserved by enclosing in standard monument boxes. Monument box castings shall be furnished and installed by CONTRACTOR and shall be East Jordan Iron Works No. 1570 or approved equal.
- B. Existing monument boxes shall be adjusted to meet the proposed pavement elevation by removing the castings and resetting to the required elevation. Support for the monument box shall be concrete bedding, so constructed as to hold them firmly in place. The adjacent pavement, curb, or curb and gutter shall be replaced to the new elevation, condition, and kind of construction, unless otherwise provided.

3.31 Testing

- A. During the course of the Work, ENGINEER may require testing for mix designs, aggregate gradation, and physical properties, bitumen content, compaction or density, and thickness of material. Testing and coring required shall be performed by a testing laboratory approved by ENGINEER. Cost for testing and coring shall be at the expense of OWNER. The testing laboratory shall furnish ENGINEER with two certified copies of the results of all tests.
- B. Testing procedures shall conform to current MDOT Standards for Construction.
- C. Testing of asphalt binders, liquid asphalts, asphalt emulsions, tars shall conform to MDOT, Section 904.
- D. Rolling shall proceed until the required compaction is attained and the amount of rolling required shall be based on the test results of a nuclear gage or on using a specified minimum number of rollers. When the total tonnage for the Project is in excess of 1,000 Tons (900 metric tons), the nuclear gage method will be used to govern the compactive requirements.
- E. Control density for the bituminous mixture to be placed, will be determined by use of a modified Marshall Test.
- F. Control Density:

1. During CONTRACTOR's start-up operations, a rolling procedure to attain the control density will be established.
 - a. Rolling procedure will be based on the number and type of rollers used and the rolling pattern.
 - b. Goal of the compactive effort will be to establish a rolling procedure which will achieve 100% of the control density but in any case, the density achieved shall not be less than 95% of the control density.
 - c. Density values less than 98% will be sufficient cause for ENGINEER to require an adjustment in the number or type of rollers being used or in the rolling pattern.
2. Once the procedure has been established on the start-up section, the procedure shall be used for the remainder of the mixture to be placed, unless subsequent tests indicate a need to change the number of rollers or the rolling pattern.
3. If difficulties are encountered or if there is a significant change in aggregate or bitumen content, ENGINEER will determine the control density for the new mixture and require CONTRACTOR to again establish the number and type of rollers and the rolling pattern required on the new mixture to attain the control density. Compactive procedures thus determined shall be used when placing the remainder of that mixture.
4. Density checks will be made at the discretion of ENGINEER to determine if the compactive procedure being used is achieving the required density, or if a change in procedure is necessary.
5. Each layer of bituminous mixture shall be compacted to at least 95% of the control density, using the established procedure.

3.32 Price Adjustments

- A. Samples of asphalt binder may be taken prior to incorporation into the mixture and from the bituminous mixture. Where results of tests on these samples deviate from specification requirements, the affected material will be subject to price adjustments on the following basis:
 1. When the test results deviate from the limits specified in MDOT, Table 904-1, Performance Graded Asphalt Binder Specification, by ten (10) percent or more, the mixture produced will be evaluated by ENGINEER and if in his judgment the defective pavement warrants removal, CONTRACTOR shall remove and replace the affected area at his expense. If it is determined that the removal is not required, the Contract unit price of the affected mixture will be reduced by ten (10) percent.
 2. Core samples may be taken on the completed Work. If the results from testing of the core samples indicates a deficiency in the completed Work, ENGINEER will evaluate the test results and will recommend removal and replacement or a credit to OWNER.

Table A: Composition of Mixtures										
Mixture No.	2B	2C	3B	3C	4B	4C	13	13A	11A	36A
Binder %	4-6	4-6	4.5-7	4.5-7	5-8	5-8	5-8	5-8	4-6	5.5-8
Percent Passing Indicated Sieve										
1-1/2" (37.5 mm)	100	100							100	
1" (25 mm)	99-100	99-100	100	100					90-100	
3/4" (19 mm)	90 max	90 max	99-100	99-100	100	100	100	100	70-95	
1/2" (12.5 mm)	78 max	78 max	90 max	90 max	99-100	99-100	75-95	75-95	55-85	100
3/8" (9.5 mm)	70 max	70 max	77 max	77 max	90 max	90 max	60-90	60-90	40-80	92-100
No. 4 (4.75 mm)	52 max	52 max	57 max	57 max	67 max	67 max	45-80	45-80	25-65	65-90
No. 8 (2.36 mm)	15-40	15-40	15-45	15-45	15-52	15-52	30-65	30-65	15-50	55-75
No. 16 (1.18 mm)	30 max	30 max	33 max	33 max	37 max	37 max	20-50	20-50	10-40	
No. 30 (600 um)	22 max	22 max	25 max	25 max	27 max	27 max	15-40	15-40	7-32	50-20
No. 50 (300 um)	17 max	17 max	19 max	19 max	20 max	20 max	10-25	10-25	5-20	
No. 100 (150 um)	15 max	15 max	15 max	15 max	15 max	15 max	5-15	5-15	4-12	
No. 200 (75 um)	3-6	3-6	3-6	3-6	3-6	3-6	3-6	3-6	3-6	3-10
Crushed Min. %	50	90	50	90	50	90	0	25	25	60

Table B: Mix Design Criteria

Mixture No.	2B	2C	3B	3C	4B	4C	13	13A	11A	36A
VMA Min. %	13.5	13.5	15	15	16	16	15.5	15.5	13.5	16.5
Air Voids % Target (1)	3	3	3.5	3.5	3.5	3.5	3	3	3	3
Fines/Binder Ratio Max. (2)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Fine Aggregate Angularity Min. (3)	3	4	3	4	3	4	2	2.5	2.5	3
Flow-in. (mm)	.08-.16 (2.0-4.0)	.08-.16 (2.0-4.0)	.08-.16 (2.0-4.0)	.08-.16 (2.0-4.0)	.08-.16 (2.0-4.0)	.08-.16 (2.0-4.0)	.08-.16 (2.0-4.0)	.08-.16 (2.0-4.0)	.08-.16 (2.0-4.0)	.08-.16 (2.0-4.0)
L.A. Abrasion Max. % loss (4)	40	40	40	40	40	40	40	40	50	40
Soft Particle Max. % (5)	12	12	12	12	8	8	8	8	12	8
Stability Min. Pounds (kN)	1200 (5.3)	1200 (5.3)	1200 (5.3)	1200 (5.3)	1200 (5.3)	1200 (5.3)	900 (4.0)	900 (4.0)	900 (4.0)	900 (4.0)

Notes:

- (1) The JMF target may be adjusted in the field, prior to placement, to meet the project design criteria for a specific application; for example, 2.0 percent air voids on shoulders or bike paths.
- (2) Fines/Binder Ratio. The ratio of aggregate material finer than the No. 200 (75 um) sieve to asphalt binder content by weight including fines and bituminous contributed by reclaimed asphalt pavement (RAP).
- (3) The fine aggregate angularity of blended aggregate, determined by MTM 118, must meet the minimum requirement. In mixtures containing RAP, the required minimum fine aggregate angularity must be met by virgin material.
- (4) Los Angeles abrasion loss must be met for the composite mixture; however, each individual aggregate must be less than 50.
- (5) The sum of the shale, siltstone, structurally weak, and clay-ironstone particles shall not exceed 8.0 percent for aggregates used in top course. The sum of the shale, siltstone, structurally weak, and clay-ironstone shall not exceed 12 percent for base and leveling courses.

Table C: Uniformity Tolerance Limits For Bituminous Mixtures						
Type of Course	Range (a)	Percentage Passing Designated Sieves				Asphalt Binder Content
		(b)	No. 8 2.35 mm	No. 30 600 μ m	No. 200 75 μ m	
Top and Leveling Course	Range 1	± 5.0	± 5.0	± 4.0	± 1.0	± 0.40
	Range 2	± 8.0	± 8.0	± 6.0	± 2.0	± 0.50
Base Courses	Range 1	± 7.0	± 7.0	± 6.0	± 2.0	± 0.40
	Range 2	± 9.0	± 9.0	± 9.0	± 3.0	± 0.50
Notes: (1) This range allows for normal mixture and testing variations. The mixture shall be proportioned to test as closely as possible to the Job Mix Formula. (2) This includes all sieve sizes No. 4 (4.75 mm) and larger listed on the Job Mix Formula.						

Table A ¹ : Composition of Mixtures									
Total Percent Passing Indicated Sieve (a)									
Mixture No.	No. 1800 No. 1500 No. 1300 (36A)(36B)	No. 1800 No. 1500 No. 1300 (20AAA)	No. 1100 (36A) (36B)	NO. 1100 (20AA)	NO. 1100 (20A)	No. 900 (20AA)	No. 900 (20A)	No. 900 (20B)	No. 700 No. 500 (20C)
1-1/2" (37.5 mm)	-	-	-	-	-	-	-	-	100
1" (25 mm)	-	-	-	-	-	-	-	-	80-100
3/4" (19 mm)	-	100	-	100	100	100	100	100	-
1/2" (12.5 mm)	100	90- 00	100	90-100	-	90-100	-	-	-
3/8" (9.5 mm)	92-100	65- 5	92-100	65-95	60-90	65-95	60-90	60-95	55-90
No. 4 (4.75 mm)	65-90	55- 5	65-90	-	-	-	-	-	-
No. 8 (2.36 mm)	55-75	45- 0	55-75	45-70	40-65	45-70	40-65	40-70	30-55
No. 30 (600 um)	25-50	20- 5	25-50	20-45	20-40	20-45	20-40	20-45	15-40
No. 200 (75 um)(b)	4 -10	3-0	4-10	3-10	3-10	3-10	3-10	3-10	3-10
Binder % (c)	5-9	5- 9	5-9	5-7	5-7	5-7	5-8	5-8	3-6
Crushed Min. %	(d)	60	(d)	40	25	40	25	-	-
Notes: (a) Composition limits are shown in percent by weight, based on the total aggregate, including mineral filler in the mixture. (b) The Job-Mix-Formula shall have a minimum total percent passing a No. 200 sieve of 5.0 percent. (c) The percent of bitumen in the mixture shown in Table A1 is a range and the actual bitumen content in the production mixture shall be as determined by the Job-Mix-Formula. For mixtures No. 900, 1100, 1300, 1500, and 1800 placed in two courses, the leveling course will be designed to have up to 0.5 percent less bitumen than the optimum specified for the top course. Mixtures No. 500 and 700 will be designed to have a target air void of 4.0 percent. (d) 36A = 60%, 36B = 40%									

Table B ¹ : Mix Design Criteria					
Mixture No.	Aggregate Required	Stability Pounds (Minimum)	Flow (.00 inch)	VMA % (Minimum)	Air Voids % Target
500	20jC	500	-	13.0	4.0
700	20C	700	8-16	13.0	4.0
900	20B, 20A, 20AA	900	8-16	13.5	2.5
1100	20A, 20AA, 36A, 36B	1100	8-16	13.5	3.0
1300	20AAA, 36A, 36B	1300	8-16	14.0	3.0
1500	20AAA, 36A, 36B	1500	8-16	14.0	3.0
1800	20AAA, 36A, 36B	1800	9-16	14.0	3.0

End of Section

Section 32 1313 Concrete Paving

Part 1 General

1.01 Scope of Work

- A. This Section includes both plain and reinforced portland cement concrete paving complete with concrete material admixtures, joints, forms, equipment requirements, field quality control and appurtenances required to complete the portland cement concrete paving Work indicated on the Plans.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200
- B. Section 31 2313
- C. Section 31 2319
- D. Section 32 1123
- E. Section 32 1723
- F. Section 32 9219

1.03 Reference Standards

- A. Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications.
 - 1. ASTM - ASTM International
 - 2. AASHTO - American Association of State Highway and Transportation Officials
 - 3. ACPA - American Concrete Paving Association
 - 4. MDOT - Michigan Department of Transportation, Standard Specifications for Construction, latest edition

1.04 Material Reports

- A. At the request of ENGINEER, CONTRACTOR shall provide ENGINEER with certification that the various materials to be used conform to the Standards referred to in the Specifications.
- B. CONTRACTOR shall submit a list of his source of material supply to ENGINEER for review prior to placing any order.
- C. CONTRACTOR shall provide ENGINEER, prior to the actual delivery of the ready-mixed concrete, the mix design as required by paragraph 5.3.2 of ASTM C94.

1.05 Thickness and Compressive Strength Reports

- A. The testing lab shall provide the ENGINEER with two (2) certified copies of the test results of the thickness and compressive strength of the concrete. The core drilling, testing for thickness and compressive strength, and the certification of the test results shall be performed by a testing laboratory approved by ENGINEER.

1.06 Water Quality Test Reports

- A. The testing lab shall provide ENGINEER with two (2) certified copies of the test results of the quality of water to be used in the concrete.
- B. Sampling and testing of water quality shall be in accordance with AASHTO T-26 requirements, and the certification of the tests' results shall be performed by a testing laboratory approved by ENGINEER.

1.07 Request for Material Variance

- A. Requests for variances in the materials, as specified, shall be made in writing to ENGINEER.
- B. Two (2) copies of the request shall be submitted for ENGINEER's review and approval.

1.08 Environmental Requirements

- A. Comply with the requirements for concrete installation due to outside ambient air temperatures specified under Articles 3.21 and 3.22 of this Section.
- B. Comply with the requirements for protecting new Work against damage from rain, as specified under Article 3.20 of this Section.
- C. Comply with the requirements for protecting new Work against damage from cold weather, as specified under Article 3.21 of this Section.

Part 2 Products

2.01 Cement

- A. Cement shall be low alkali, air-entraining Portland cement conforming to ASTM C150, Type IA or Type IIIA.

2.02 Fine Aggregates

- A. Fine aggregate gradation shall conform to ASTM C33 and to fine aggregate, 2NS, as specified in MDOT Section 902.

2.03 Coarse Aggregate

- A. Coarse aggregate gradation shall conform to ASTM C33 and to coarse aggregate, 6A, or 6AA as specified in MDOT Section 902.

2.04 Water

- A. Water to be used for mixing and curing concrete shall be reasonably clean and free from oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product.
- B. Waters from sources approved by the Michigan State Department of Public Health as potable may be used without testing.

- C. Water requiring testing shall be tested in accordance with the current Method of Test for Quality of Water to be used in Concrete, AASHTO T-26, and specified in MDOT Section 911.

2.05 Concrete Admixtures

- A. Air-Entraining Admixtures:
 - 1. Air-entraining admixtures for concrete shall conform to ASTM C260 and as specified in MDOT Section 903.
- B. Concrete Accelerators:
 - 1. Chemical admixtures, other than calcium chloride, for accelerating the set of Portland cement concrete shall conform to ASTM C494, Type C or Type E.
 - 2. Calcium chloride in flake or pellet form shall conform to ASTM D98, Type S, Grade 1 or grade 2, flake or pellet form, and as specified in MDOT Section 903.
 - 3. Calcium chloride in solution form shall conform to MDOT Section 903.
- C. Water-Reducing and Water-Reducing Retarding Admixtures:
 - 1. Water-reducing admixtures and water-reducing retarding admixtures shall conform to ASTM C494, Type A or Type D, except that neither type of admixture shall contain calcium chloride, and as specified in MDOT Section 903.
- D. Pozzolanic Admixtures:
 - 1. Fly Ash shall conform to ASTM C618, Type F, and as specified in MDOT Section 901.
 - 2. Ground granulated blast furnace slag shall conform to ASTM C989, Grade 100, minimum.

2.06 Concrete Curing Compounds

- A. White membrane curing compound for curing concrete shall conform to ASTM C309, Type 2, Class B Vehicle, and as specified in MDOT, Section 903.05.
- B. Transparent membrane curing compound for curing base course concrete shall conform to ASTM C309, Type 1-D, Class B Vehicle, and as specified in MDOT, Section 903.05.

2.07 Lane Tie Bars

- A. Bar reinforcement for pavement tie bars shall conform to ASTM A706, or Grade 60 of ASTM A615, A616-96a, or A617-96a, and as specified in MDOT Section 914.

2.08 Steel Welded Wire Fabric

- A. Welded steel wire fabric for concrete mesh reinforcement shall conform to ASTM A185, MDOT Section 905, and shall be fabricated as shown on the Plans.

2.09 Dowel Bars

- A. Dowel Bars and basket assemblies for Transverse expansion and contraction joints shall be ASTM A615 Grade 40 and conform to MDOT Section 914.

2.10 Steel Hook Bolts

- A. Hook bolts shall conform to ASTM A706, or Grade 60 of ASTM A615, A616-96a, or A617-96a. Hook bolts shall be 5/8 inch (16 mm) diameter. Along the edge of existing concrete, expansion anchored hook bolts shall be used.

2.11 Joint Fillers

- A. Fiber joint filler material for expansion joints shall conform to ASTM D1751, and as specified in MDOT, Section 914.03.
- B. Bituminous premolded joint filler material shall conform to ASTM D994 and AASHTO M33.
- C. Polyethylene premolded joint filler for pressure relief joints shall be a flexible, low-density, expanded, extruded polyethylene plank. Polyethylene plank shall be formed by the expansion of polyethylene base resin in an extrusion process and shall be homogeneous, closed-cell and multi-cellular.

2.12 Joint Sealants

- A. Hot-poured type joint sealant shall conform to AASHTO M301 or ASTM D6690 Type II and as specified in MDOT Section 914.
- B. Cold-applied, single component type, joint sealant shall conform to ASTM D5893.

2.13 Concrete Mix

- A. Concrete shall contain a minimum of six (6) sacks, 94 pounds per sack, of cement per cubic yard (335 kg/m³) and shall yield a minimum compressive strength of 3,500 psi (24 Mpa) when cured in a moist room at a temperature within a range of 65 to 75 degrees Fahrenheit (18° to 24° Celsius) for a period of 28 days.
 - 1. Mixes with less than six sacks of cement per cubic yard with water reducers, pozzolans, ground granulated blast furnace slag (GGBFS), etc., may be used when approved by ENGINEER, providing CONTRACTOR provides documentation from actual mixes used on projects showing 28 day compressive strength of not less than 3,500 psi when tested under field conditions.
 - 2. GGBFS or Fly Ash must replace cement on a pound for pound basis. The fly ash quantity may not exceed 15%, GGBFS quantity shall be not less than 25% and not more than 40%. Maximum total replacement of cement shall not exceed 40%.
- B. Cement shall be air-entraining Portland cement ASTM C150, Type IA. If high-early strength concrete is desired, Type IIIA is required.
- C. High early strength concrete shall be 4500 psi (31 MPa), 7 sacks cement per cubic yard (390 kg/m³) with a water reducer. Water cement ratio shall be between 0.38 and 0.39.

- D. Air content of the concrete shall be dependent on the maximum size aggregate as follows:

Size of Aggregate in inches (mm)	Air by Volume (in % $\pm 1\%$)
1-1/2, 2, or 2-1/2 (40 to 65 mm)	5
3/4 or 1 (20 to 25 mm)	6
3/8 or 1/2 (9 or 10 mm)	7-1/2

- E. Slump of the concrete shall be between 1-1/2 and 2-1/2 inches (40 to 65 mm) where machine methods are used for striking off and consolidating the concrete. If ENGINEER permits hand finishing, the slump may be increased to 3-1/2 inches (90 mm).
- F. Ready-mixed concrete shall be in accordance with ASTM C94, Alternate 2, and shall yield a minimum compressive strength of 3,500 psi (24 Mpa) when cured in a moist room at a temperature within a range of 65 to 75 degrees Fahrenheit (18° to 24° Celsius) for a period of 28 days.
- G. ENGINEER shall be provided with the mix design for review and approval, prior to the actual delivery of the concrete.

Part 3 Execution

3.01 Verification of Excavation and Forming

- A. Prior to the installation of any concrete, examine the excavation and forms for the grades, lines, and levels required to receive the new Work. Ascertain that all excavation and compacted subgrades are adequate to receive the concrete to be installed.
- B. Correct defects and deficiencies before proceeding with the Work.

3.02 Verification of Subgrade Conditions

- A. Prior to the installing of any concrete, examine the subgrade to ascertain that it is adequate to receive the concrete to be installed. If the subgrade remains wet after all surface water has been removed ENGINEER may require the installation of edge drain.

3.03 Existing Improvements

- A. Investigate and verify location of existing improvements, including structures, to which the new Work is to be connected. Make necessary adjustments in line and grade to align the new Work with the existing improvements after approval by ENGINEER.

3.04 Batch Plant

- A. An adequate site for the batch plant shall be obtained by CONTRACTOR, at his expense. The site shall be maintained, and the plant operated in accordance with the conditions and requirements established by the community in which the plant is located.

3.05 Fine Grading

- A. Subgrade shall be fine graded to the cross section shown on the Plans and shall be thoroughly compacted prior to the placing of forms or concrete.

3.06 Installation - General

- A. The width, thickness, and type of concrete pavement shall be specified on the Plans or as approved by ENGINEER.
- B. At street intersections, curb drops, conforming to the current rules and regulations of Act 8, Michigan PA 1973, shall be provided for the construction of sidewalk ramps. In addition, curb drops for sidewalk and driveway approaches shall be provided as specified in locations called for on the Plans or as approved by ENGINEER.
- C. Construction operations shall be restricted to the existing right-of-way. If additional area is required, CONTRACTOR shall furnish ENGINEER with written permission from the property owner for any part of the operation he conducts outside the established right-of-way.
- D. CONTRACTOR shall maintain traffic access at all intersections. Vehicle access shall also be maintained to all commercial and public properties and elsewhere as designated by ENGINEER.

3.07 Equipment Requirements

- A. General:
 - 1. Approved, mechanical concrete placing and finishing equipment shall be used for concrete paving except for gapped areas or where otherwise approved by ENGINEER.
 - 2. CONTRACTOR shall furnish sufficient equipment for the placing of concrete pavement.
 - 3. Equipment shall be on the job site and ready for normal operation before the paving operation is started.
 - 4. Equipment shall be in good working order.
 - 5. Equipment shall be subject to inspections and testing during construction.
 - 6. Equipment shall be of sufficient capacity that the paver can operate continuously and obtain a rate of production that insures good workmanship and eliminates overloading of equipment or frequent interruptions or delays.
 - 7. Equipment operating on or near the pavement shall be equipped with rubber-tired wheels.
- B. Forms:
 - 1. Except when paving with a slip-form paver, forms shall be used and shall be made of metal, having an approved section, which shall insure their rigidity under impact, thrust and weight of the heaviest machine carried on them.
 - a. The thickness of the metal shall be not less than 1/4 of an inch (5 mm), except that a minimum thickness of 3/16 of an inch (4.5 mm) will be permitted if the form is a trapezoidal cross section.

2. Forms shall have a minimum length of ten (10) feet (3 m) and a depth not less than the edge thickness of the Work prescribed, except the subgrade may be a maximum of 1-inch (25 mm) lower than the bottom of the forms when so approved by ENGINEER.
 - a. The width of the base in direct bearing on the soil shall be not less than 0.75 of the form depth except that a width of less than eight (8) inches (200 mm) will not be permitted.
 3. Each 10-foot (3 m) section of form shall have at least three (3) stake pockets. The forms shall be straight, free from distortion, and shall show no vertical variation greater than 1/8 of an inch (3 mm) in 10-foot lengths (3 m) from the true plane surface on the top of the form when tested with a 10-foot (3 m) straightedge and shall show no lateral variation greater than 1/4 of an inch (5 mm) from the true plane surface on the vertical face of the form when tested with a 10-foot (3 m) straightedge.
 4. Approved wood or flexible forms and hand finishing will be required on all pavement where the radius for the edge of the pavement is less than 200 feet (60 m).
 5. The method of connection between form sections shall be such that a locked joint is formed free from vertical movement in excess of 1/8 of an inch (3 mm) and from horizontal movement in excess of 1/4 of an inch (5 mm) under the impact, thrust and weight of the heaviest machine carried on the forms.
 6. Sufficient forms shall be provided so that it will not be necessary to remove them in less than 12 hours, or longer if required, after the concrete has been placed.
- C. Subgrade Roller or Compactor:
1. Equipment shall be self-propelled steel-wheeled or a pneumatic-tired roller weighing not less than eight (8) Tons (7 metric tons) or a self-propelled vibratory compactor of adequate size to compact the subgrade to the required density.
- D. Subgrade Planer:
1. Steel-shod subgrade planer supported by two (2) flanged wheels resting on the side forms may be used for trimming the subgrade in small areas when approved by ENGINEER.
 2. Steel-shod template shall be adjustable to fit the shape of the bottom of the pavement and shall have adequate connection to a rigid frame to maintain the crown.
 3. Planer shall be of sufficient weight to plane off all high spots encountered.
- E. Base Trimmer:
1. For slip-form construction, a powered, self-propelled base trimmer will be required. This base trimmer shall be capable of trimming the base to the required cross section.

F. Water Supply Equipment:

1. Pumps and pipe lines shall be such capacity and nature as to insure an ample supply and adequate pressure of water, simultaneously, for all the requirements of machinery, mixing, sprinkling subgrade, and other requirements of the Work
2. Water may be supplied in tank wagons to augment inadequate pipe lines or to replace them entirely if a sufficient number of units are employed.

G. Finishing Machine:

1. Finishing machine shall be power driven and of an approved type which will strike off and compact the concrete with a screeding and troweling action.
 - a. Machine shall be capable of finishing the concrete in the manner specified herein, and shall provide a minimum of two (2) oscillating screeds.
2. A combination concrete spreader/finishing machine (i.e.: Pav-Saver®) may be used for residential streets not exceeding 100-feet (305 m) in length and 18-feet (3.7 m) in width or when approve by ENGINEER.
 - a. The combination type machine must have suitable automatic vibrators, strike-off bars, augers, screeds, finishing pan, etc., in accordance with the requirements of this section, to produce a densely compacted, homogeneous concrete slab, true to line, grade and cross section.

H. Concrete Spreader:

1. An approved concrete spreader with a strike-off board or a separate strike-off shall be used to level each layer of concrete, before placing of reinforcement, and before finishing the concrete.
 - a. It shall have sufficient weight and rigidity to retain its shape under working conditions to properly strike off the concrete.
 - b. Two separate spreaders are not required where an approved mesh depresser type machine is used.
2. A concrete spreader is not required for the construction of residential street concrete pavement when approved by ENGINEER.

I. Vibratory Screed:

1. An approved hand-propelled vibratory screed shall be provided for use in gapped areas at driveways and intersections, and where machine methods are not feasible to screed and consolidate the concrete.
 - a. Gaps finished by this method shall be limited to one (1) joint spacing in length and one (1) single lane width.
2. Screed shall consist of a steel-shod strike board having a minimum thickness of two (2) inches (50 mm) and equipped with a gasoline engine capable of producing at least 5,000 vibrations per minute.

- a. Other vibratory screeds may be approved by ENGINEER.
- J. Membrane Sprayer:
 - 1. A mechanically-pumped pressure sprayer capable of applying a continuous uniform film of curing compound will be required.
 - 2. Equipment shall provide adequate stirring of the compound during application.
- K. Slip-Form Paving Equipment:
 - 1. When pavement is placed by the slip-form method, the slip-form paving equipment shall spread, consolidate, screed, and mechanically float the freshly-placed concrete in such a manner that only a minimum of hand finishing will be necessary to provide a dense and homogeneous pavement.
 - 2. The machine shall be equipped to vibrate the concrete for the full width and depth of the pavement being placed.
- L. Floats:
 - 1. Mechanical float shall be a combination float finisher. Where a mechanical float is an integral part of a slip-form paver, a separate mechanical float will not be required.
 - 2. A float finisher shall consist of a machine having two (2) screeds and be equipped with a suspended pan float. The second screed and the pan float shall be suspended in such a manner that they operate independently of the side forms.
 - 3. A mechanical float will not be required for the construction of residential street concrete pavement.
- M. Footbridge:
 - 1. A movable bridge shall be provided when necessary to satisfactorily finish the pavement or construct joints. The bridge shall be designed and constructed so that it will not come in contact with the concrete.
- N. Transverse Float:
 - 1. This float shall be made of metal and shall be at least ten (10) feet (3 m) in length and of the box or channel type with a floating face at least six (6) inches (150 mm) in width. It shall be constructed so as to be light in weight, rigid and free from warps.
- O. Vibrator:
 - 1. Vibrator for consolidating the concrete along the faces of the forms and adjacent to joints shall be an approved electric or mechanical vibrator of an internal type, not less than 2 inches (50 mm) in diameter.

2. It shall have minimum frequency of 5,000 vibrations per minute for a tube 2 inches (50 mm) in diameter, 3,600 vibrations per minute for a tube 4 inches (100 mm) in diameter, or a proportionate frequency for an intermediate size.
3. At least 2 vibrators shall be provided for each concrete paving unit on the project.
4. Vibrators used adjacent to the forms in conventional paving shall be connected with the equipment on which they are mounted such that vibration of the concrete will start automatically with the forward movement of the equipment and stop automatically whenever forward movement stops.

P. Form Tamper:

1. A mechanical form tamper of approved design will be required on all projects. It shall be capable of thoroughly and uniformly compacting the soil under the forms.

Q. Strike-Off for Reinforcement:

1. An approved strike-off shall be used to level the concrete before placing the pavement reinforcement.
2. It shall be adjustable and shall be supported by two (2) flanged wheels on each end which rest on the side forms.
3. It shall have sufficient weight and rigidity to retain its shape under working conditions and properly strike off the concrete.
4. An approved hand strike-off resting on the forms shall be used for irregular areas.
5. The strike-off may be a part of the concrete spreader or a finishing machine.

R. Lane Tie Bar Installer:

1. When not placed on approved chairs, lane tie bars shall be installed by use of an approved mechanical device.

S. Reinforcement Carrier:

1. Reinforcement not placed on chairs shall be transferred from the hauling equipment to a movable bridge which spans the pavement being cast or placed by other approved means which will not result in contamination of the concrete.
2. Bridge shall be capable of carrying the reinforcement load without appreciably deflecting the forms.

T. Joint Filling and Sealing Equipment:

1. Equipment for filling and sealing joints shall be available for inspection and testing at least 48 hours prior to its use.

2. Heating kettle for hot poured sealing material shall be of the indirect-heating or double boiler type, using oil as the heat transfer medium. It shall have a thermostatically controlled heat source, a built-in automatic agitator, and thermometers installed to indicate both the temperature of the melted sealing material and that of the oil bath.
 - a. CONTRACTOR shall demonstrate that the equipment proposed for use will consistently produce a joint sealer of proper pouring consistency.
 3. Hot-poured sealing material shall be applied directly from the heating kettle; the kettle shall be equipped with a pressure pump, hose and nozzle suitable for forcing the sealing material to the bottom of the joint and completely filling the joint.
 - a. The rate of application shall be controlled so as to completely fill the joint and not spill the material on the surface of the pavement.
 - b. The hose and nozzle shall maintain the temperature of the sealing materials so that the loss in temperature is not over 10 degrees Fahrenheit (12° Celsius) between the nozzle and the heating tank.
 - c. Heat from a direct flame on the nozzle shall not be used to maintain the proper temperature of the sealing material.
 - d. Heating equipment shall be mounted on rubber-tired wheels, and only rubber-tired equipment shall be used to move the heating equipment on the pavement.
 4. Cold applied sealing compound shall be applied by means of pressure equipment that will force the material to the bottom of the joint and completely fill the joint without overflowing onto the surface of the pavement.
 5. Sealing machine shall include a mechanical mixer capable of mixing the sealing components into a uniform, homogeneous mass.
- U. Preformed Neoprene Joint Sealing Equipment:
1. Equipment for applying the lubricant and installing the preformed joint seal may be either power or hand operated equipment suitable for installing the joint seal as recommended by the manufacturer.
- V. Sandblasting Equipment or Power Wire Brush:
1. Sandblasting equipment shall be of proper size and capacity to obtain the cleaning specified and shall operate at a nozzle pressure adequate for the performance of the Work. Nozzles shall be of proper diameter in relation to the width of joint and shall be replaced as necessary due to enlargement by wear.
 2. A power wire brush may be used in place of sandblasting equipment.
- W. Air Compressors:
1. Air compressors shall be portable and capable of furnishing sufficient air to maintain a nozzle pressure adequate to remove all loose fragments of concrete and foreign material from the joints.

2. Suitable traps shall be employed to maintain the compressed air free of oil and moisture.
- X. Power Broom:
1. A mechanical broom with pickup suitable for cleaning the pavement will be required.
- Y. Concrete Saw:
1. Two (2) self-propelled concrete saws which are adequately powered to cut hardened concrete to a minimum depth as shown on the Plans will be required.
 2. Minimum thickness of the saw blade shall be 3/16 of an inch (5 mm). Saws shall be equipped with suitable guards.
- Z. Miscellaneous Equipment:
1. Small tools to completely and satisfactorily finish the Work, including straightedges for testing pavement and forms, shall be provided by CONTRACTOR.

3.08 Placement of Forms

- A. Forms shall be placed and checked for line and grade at least 500 feet (150 m) in advance of placing concrete.
- B. Forms shall be adequately staked and braced to resist the pressure of concrete and the thrust of the equipment.
- C. Forms shall have uniform bearing on the subgrade throughout their entire length and width.
- D. After setting the forms to grade, thoroughly tamp both the inside and outside with an approved mechanical form tamper.
- E. Forms shall be thoroughly cleaned before they are placed.
- F. Forms shall be neatly and tightly joined, and shall be securely staked by at least three (3) stakes per form.
- G. Forms shall be oiled before concrete is placed against them.
- H. Forms shall be checked for line and grade, after being set.
- I. Forms showing a variance from the staked line by more than 1/4 inch (5 mm) or from the staked grade by more than 1/8 inch (3 mm) in ten (10) feet (3 m) shall be adjusted.
- J. Where the use of flexible forms are required, sufficient back bracing shall be provided to prevent undue deflection of the forms during placement of the concrete.

3.09 Placing Concrete

- A. Placing of concrete should not commence or continue until the condition of the subgrade has been approved by ENGINEER.

- B. Concrete shall be spread or distributed as soon as placed. If a mechanical spreader is not used, the concrete shall be deposited in a manner that requires a minimum of re-handling to avoid segregation and separation of materials. Concrete shall be deposited to a height sufficiently above grade so that when consolidated and finished it shall conform to the required finished grades.
- C. Concrete along the faces of forms and adjacent to joints shall be consolidated and compacted to fill all voids.
- D. Forms shall not be vibrated to consolidate the concrete.
- E. When the pavement is placed in two (2) layers, the first layer may be cast three (3) to six (6) inches (75 to 150 mm) narrower on each side than the proposed pavement slab, so that the full depth of pavement, at the edges, will be cast with the second layer. Equipment shall vibrate concrete placed full depth for the complete width and depth of the pavement being placed. For concrete placed in two (2) layers, only the second layer will be required to be vibrated.
- F. Placing of concrete shall be continuous as much as possible between transverse joints.
- G. Whenever a temporary halt in operation occurs, the concrete and unfinished end of the slab shall be covered with wet burlap or plastic.
- H. If the interruption of Work continues for more than 20 minutes, a construction joint shall be placed, provided the proposed construction joint is 15 feet (4.5 m) or more from the last joint for reinforced pavement and at least ten (10) feet (3 m) or more from the last joint in plain concrete pavement. Sections of pavement shorter in lengths will not be permitted and, if constructed, shall be removed and replaced at CONTRACTOR's expense.
- I. Integral curbs, where specified or required, shall be constructed monolithic with the pavement slab. Curb material shall be placed before the pavement has started its initial set and shall be of the same mix as the concrete pavement.
- J. Base and back forms will be required when constructing straight curbs, and back forms with templates of the required curb shape shall be used when constructing rolled and mountable curbs. Curb concrete shall be spaded sufficiently to eliminate all voids and tamped to bring the mortar to the surface, after which the curb shall be given a final finish to match the texture of the pavement.
- K. After removing forms, any visible areas of honeycomb or minor defects shall be immediately filled with mortar, having one part of Portland cement and two parts fine aggregate, and shall be applied with a wooden float.
- L. Where adjacent pavement lanes are constructed in separate pours, no equipment shall be operated upon recently placed concrete until the pavement has attained at least 85% of the design strength as determined by testing cores taken from the project, or until the pavement is 14 days old, at the option of ENGINEER.
- M. Equipment wheels operating on the pavement, shall operate at least one foot (300 mm) from the edge of the pavement. Equipment wheels shall be rubber-tired.

- N. The paver shall not be permitted on the new slab until the pavement has attained full design strength. The paver shall not operate on any new slab without using wood mats having an approved thickness and width to insure that the pavement will not be marked or structurally damaged.
- O. Pavers are not permitted to operate on residential streets.
- P. If the curing compound is damaged, it shall be repaired by spraying additional curing compound on the damaged areas as soon as the Work is completed.
- Q. The filler strip on pavement widening projects shall be poured as soon as possible but not later than the first working day following the placing of the slab.
- R. At intersections and where access is required to property along the Project, construction shall be completed by gapping the proposed pavement. Load transfer, contraction, of end-of-pour joint devices shall be placed at the gapped ends of the pavement.
- S. In lieu of pavement gapping, CONTRACTOR may elect to place a temporary bridge, of a design approved by ENGINEER, to provide access. Furnishing, placing, maintaining, and removing the bridge shall be at CONTRACTOR's expense.

3.10 Placing Pavement Reinforcing

- A. Where reinforcement is required, the sheets or mats shall be placed at the depth below the surface of the finished pavement, as shown on the Plans.
- B. Pavement reinforcement shall be shipped and delivered to the Work in flat sheets or mats.
- C. Adjacent sheets or mats shall be lapped, as indicated on the Plans, and shall be fastened to each other in no less than two (2) places in each pavement lane.
- D. Where the width of pavement varies, the reinforcement requirements shall be the same as called for on the Plans. Split sheets or mats may be used to conform to the particular pavement configuration. Side laps shall not be less than the spacing of the longitudinal wires or bars.
- E. On widening Projects where the pavement slab is less than six (6) feet (1.8 m) in width, 1/2 inch (10 mm) diameter longitudinal reinforcing bars may be substituted for standard reinforcement, providing the bars are spaced not more than 12 inches (300 mm) center-to-center. The first bar shall be not more than three (3) inches (75 mm) from the edges of the widened slab, and the bars shall be lapped a minimum of 12 inches (300 mm).
- F. Reinforcement shall be installed by one of the following methods:
 - 1. Chairs upon which reinforcement is to be mounted shall support the reinforcement and shall have such bearing on the base that there will be no undue penetration of the base. Maximum spacing of the chairs shall be sufficient to maintain the reinforcement at the specified depth. The reinforcement shall be placed directly from the hauling unit unto the chairs.
 - 2. When reinforcement is placed between two (2) layers of concrete, the first layer shall be mechanically spread and struck off to the required depth below the proposed finished surface. Reinforcement shall be placed directly from the carrier onto the struck off concrete.

3. Any area where the use of the mechanical spreader or mechanical strike-off is not feasible, the reinforcement shall be mounted on chairs.

3.11 Joints

A. General:

1. Longitudinal and transverse joints shall conform to the details and shall be constructed at the locations shown on the Plans or as directed by ENGINEER.
2. Joints shall be constructed true to line with their faces perpendicular to the surface of the pavement.
3. Transverse joints shall be constructed at right angles to the centerline of the pavement, unless otherwise called for on the Plans or as determined by ENGINEER. Joints shall not vary more than 1/4 of an inch (5 mm) from a true line.
4. The surface of the pavement adjacent to all joints shall be finished to a true surface. Where indicated on the Plans, joints shall be edged to the radius shown or a minimum 1/4 inch (5 mm) radius. Surface across the joints shall be tested with a ten (10) foot (3 m) straightedge as the joints are finished and any irregularities shall be corrected before the concrete has hardened.
5. When pavement is laid in partial width slabs, transverse joints in the succeeding slabs shall be placed in line with the like joints of the first slab. In the case of widening existing pavements, transverse joints shall be placed as shown on the Plans, or as directed by ENGINEER.
6. Keyways, where required, shall be accurately formed with templates of metal, wood, or paper securely pinned in place. The gauge or thickness of the material in the templates shall be such that the full keyway, as specified, is formed in the correct location.

B. Longitudinal Joints:

1. General:

- a. Longitudinal joints shall be sawed, longitudinal lane tie joint with tie bars or bulkhead construction joints with hook bolts.
- b. Where called for on the Plans a keyway shall be constructed in the bulkhead construction joint.

2. Longitudinal Lane Tie Joint (D):

- a. Longitudinal lane tie joints with tie bars shall be planes of weakness formed by sawing a groove in the hardened concrete according to the alignment, width and depth shown on the Plans.
- b. Tie bars of the type, diameter and length called for on the Plans, shall be placed at the required depth parallel to the finished surface, at right angles to the joint and at the uniform spacing also called for on the Plans or as approved by ENGINEER.

- c. Bar chairs shall be used to support the lane tie bars or the lane tie bars may be installed by use of a mechanical device, approved by ENGINEER. Placing of lane tie bars in the concrete by hand methods will not be permitted.
- d. The joint shall be sawed as soon as the concrete will not spall or not more than 3 days after placement, and shall be completed before traffic of any kind uses the pavement. Immediately following the sawing of the joint, the slurry resulting from the sawing operation shall be completely removed from the joint, and the immediate area by flushing with a jet of water under pressure.
- e. The joint shall be blown out with a jet of compressed air to remove the flushing water. After the joint is dry it shall be cleaned out with a jet of compressed air with a working pressure of at least 90 psi (620 kPa) and then shall be sealed in accordance with Article 3.18, with an application of an approved hot or cold applied type joint sealing compound. Sealing compound shall be applied with approved pressure type equipment with the nozzle extending into the groove and the groove shall be filled until the sealer overlaps the pavement about 1/8 of an inch (3 mm).

3. Longitudinal Bulkhead Construction Joint (D):

- a. Longitudinal bulkhead construction joints with hook bolts shall be used in part-width construction of concrete pavement and elsewhere as shown on the Plans, or as approved by ENGINEER. Size, spacing, and depth of the hook bolts below the surface of the pavement shall be as shown on the Plans.
- b. For slip-form paving, lane ties of an approved type may be substituted for hook bolts and shall be spaced at 30-inch (750 mm) centers, unless otherwise indicated on the Plans. Lane ties for slip-form paving shall be placed in the concrete with a pneumatic powered installer or equipment producing equal results. Lane ties, which are not set with adequate consolidation of the concrete or are not within 30 degrees of being perpendicular to the pavement edge in a horizontal plane, shall be replaced with drilled-in expansion-anchored lane ties.
- c. Where a bulkhead joint is to be constructed, hook bolts and couplings shall be attached to the forms and shall be held in position during the placing and finishing of the concrete so as to permit the removal of the pavement forms without damage to the concrete or hook bolt assembly. Ends of the couplings shall be protected so that the concrete, dirt or other materials cannot enter the couplings and prevent a satisfactory connection with either hook bolt.
- d. Where hook bolts or lane ties are installed for use in future pavement widening, in curb or curb and gutter construction, a rust preventive oil shall be inserted into the open end of the couplings immediately after removal of the pavement forms by means of a hand operated pump in sufficient quantity to completely cover the internal threads. After application of the protective oil, neoprene or plastic plugs shall be inserted into the ends of the couplings to completely seal the opening without protruding outside of the couplings more than 3/8 inch (9 mm).

- e. Concrete shall be edged with a tool having the radius of curvature and depth of lip shown on the Plans. The second pour of concrete shall be edged with a longer lipped edging tool than that used on the first concrete pour.
- f. After the concrete has cured for the required time, all extraneous material shall be removed from the joint and the joint then sealed with an approved hot-poured or cold-applied elastic-type compound. The use of sandblasters and a jet of compressed air will be required to clean the joint before sealing.

C. Transverse Joints:

1. General:

- a. Transverse joints shall be contraction joints, plane of weakness joints, dummy joints, expansion joints, construction joints, end-of-pour joints and pressure relief joints.

2. Contraction Joints (C):

- a. Contraction joints shall consist of a load transfer unit and a joint groove formed by sawing. Contraction joints shall be constructed as indicated on the Plans and shall be spaced a maximum of every 57'-3" (17.5 m) or as provided for elsewhere.
- b. The load transfer unit shall be epoxy coated dowel bars, spaced and arranged in the positions indicated on the Plans, accurately held in place by an approved metal device so as to be perpendicular to the plane of the cross section of the pavement and parallel to the centerline at a distance from the surface equal to $1/2$ the thickness of the slab.
- c. This device shall consist of connected transverse and longitudinal members arranged to hold each dowel so firmly that its final position after concreting operations shall not vary more than $1/8$ of an inch per foot of length (3 mm per meter) from its designated line and grade. The device shall be such as will permit the joint to be completely assembled alongside the Work, and it shall be sufficiently rigid so that the joint can be lifted into place on the subgrade as a unit.
- d. One end of each dowel bar shall be free to move in the slab as the concrete contracts and expands. To accomplish this, $2/3$ the length of each dowel shall be thoroughly lubricated with liquid asphalt. The liquid asphalt coating shall be applied to a sawed end of the dowel bar or, in the case of dowel bars with sheared ends, a metal cap shall be placed on the coated end of the dowel bar. The asphalt coating shall be sufficiently dry before using the dowels so that it will not be removed by handling and placing the dowels in the joint. The bars shall be installed so that the alternate bar on each side of the joint shall be the coated end of the bar.

3. Plane of Weakness Joints (WT):

- a. Plane of Weakness joints shall be placed in plain concrete pavements only and is to be constructed immediately after the finishing operation has been completed. A groove shall be formed in the plastic concrete with a metal forming bar to the depth indicated on the Plans. A premolded bituminous filler strip shall be placed in the groove formed by the metal bar, from a bridge operating on the pavement forms. The concrete shall then be floated against the sides of the filler, and the joint edged to a 1/8 inch (3 mm) radius.
- 4. Plane of Weakness Joint for Concrete Base Course (WTB):
 - a. Dummy joints shall be placed in reinforced concrete pavements only where called for on the Plans. It shall be constructed immediately after the finishing operation has been completed by forming a groove in the plastic concrete with a metal forming strip into which expanded polystyrene or other approved temporary filler is placed. The material shall be installed flush with the surface of the pavement and the area on both sides of the joint shall be finished. Transverse joints with a temporary filler shall not be edged. The pavement reinforcement shall be continuous through this joint.
- 5. Expansion Joints (E) and (E₁):
 - a. Expansion joints (E₁) shall consist of a load transfer unit and a premolded fiber filler and shall be used on reinforced concrete pavements or where shown on the plans.
 - b. Expansion joints (E) shall consist of a premolded fiber filler without the load transfer unit and shall be used for joints in concrete capping, end connections with structures or existing pavements, plain concrete pavements, and other places where shown on the Plans where installation of the load transfer unit is not feasible as approved by ENGINEER.
 - c. The load transfer units shall be assembled and the epoxy coated bars lubricated with liquid asphalt. Liquid-asphalt-coated end of each bar shall be provided with a close fitting metal cap.
 - d. The fiber filler shall extend the full depth and width of the joint. After installation, the top shall be not less than 1/2 inch (10 mm) and no more than 1-inch (25 mm) below the finished surface. It shall be furnished in lengths not less than the lane widths being poured. Where additional partial lengths are necessary, the minimum length of load transfer unit and premolded fiber filler shall be sufficient to span two (2) dowel bar spacings. Where more than one (1) section is allowed and used in a joint, the sections shall be securely joined together.
 - e. Expansion joints in curb lanes with integral curb, the fiber filler used in the pavement shall extend completely through the curb section. The fiber filler placed in the curb above the slab shall be 1-inch (25 mm) in width.

- f. During installation, the joint shall be held in place by an approved installing device which shall be securely staked. The top edge of the filler shall be protected, while the concrete is being placed, by a metal channel cap of at least 10-gage material having flanges not less than 1-1/2 inches (40 mm) in depth. The channel cap shall be shaped to the proposed crown of the pavement and shall extend over the full length of the filler.
- 6. Pressure Relief Joints (PR):
 - a. The method of constructing a pressure relief joint shall be as indicated on the Plans.
 - b. Pressure relief joint material shall be a flexible, low-density, expanded, extruded polyethylene plank. Joint material shall be cut off to 1/2 inch (10 mm) below the top of the pavement surface and shall extend entirely through and to within 1/2 inch (10 mm) of the face and top of the curb.
- 7. End of Pour Joints and Construction Joints:
 - a. End of pour joints in reinforced pavement shall be formed by placing a bulkhead and installing a load transfer device, as specified for contraction joints, except that the ends of the dowel bars shall not be lubricated. The load transfer device shall be so installed that each dowel bar will be embedded in the concrete for 1/2 of its length.
 - b. When the next pour is made, a space for hot-poured rubber joint filler shall be provided by placing temporary filler in the fresh concrete. End-of-pour joints shall be constructed using 2-piece dowels and a bulkhead and shall be placed where it is anticipated that three (3) days or more will elapse between the casting of adjacent pours.
 - c. Construction and end-of-pour joints shall be sealed as specified for transverse contraction joints.
 - d. End of pour joints in plain concrete pavements shall be formed by placing a bulkhead, fiber keyway, and installing 1/2 inch (10 mm) diameter deformed bars, 30 inches (75 mm) in length, at 18-inch (450 mm) intervals across the end of the pavement.
 - e. The pavement across the end of both slabs shall be thickened and the joint shall be edged and sealed.
- 8. Transverse joints in a concrete pavement shall extend entirely through the integral curb. The material used to construct the joint in the curb shall be of the same kind as provided for the pavement.
- 9. Bituminous fiber filler shall be used to construct the expansion joints in the integral curb of reinforced concrete pavements. The thickness of the fiber filler material in the curb above the gutter shall be 1-inch (25 mm). Joint material shall be precut so as to conform to the geometric shape and cross-sectional area of the curb, and shall be placed in intimate contact with the filler material in the pavement.

10. The edges of transverse joints in the integral curb shall be rounded with an approved finishing tool, having a radius of 1/4 inch (5 mm).

3.12 Consolidating and Finishing

- A. The sequence of operations after the placing of concrete shall be: striking off and consolidating, floating, straightedging and finishing with burlap drag, edging and final finishing with burlap drag.
- B. Mechanical methods shall be employed to strike off and consolidate or compact the concrete, except in gapped areas or where the pavement width will not permit the use of machine methods. Gaps less than 1 joint opening in length may be finished by hand methods, provided they are finished in single-lane widths.
- C. Strike off, consolidate and compact the concrete to such an elevation that when all finishing operations are completed, the surface will conform to the required finished grade and cross section. At least 4 inches (100 mm) of concrete above the finished pavement grade shall be maintained ahead of the screed for its entire length. In consolidating the surface of the pavement, on residential street construction when a single screed finishing machine is used, it shall operate over each section of the pavement twice. Only sufficient mortar shall be worked to the surface to provide a dense smooth finish. Excessive operation of the machine over a given area will not be permitted. Segregated particles of coarse aggregate which may collect in front of the screed shall be thoroughly mixed by hand with the mass of concrete already on the subgrade.
- D. If it is not possible to use mechanical equipment on irregular areas, an approved, self-propelled vibratory screed shall be employed to strike off and properly consolidate the concrete surface to the required finish grade. Where it is not possible to use a vibratory screed, a hand strike board of an approved design, will be permitted. The entire area of the pavement shall be consolidated to insure an absence of voids.
- E. Strike-off boards shall be moved forward with a combined longitudinal and transverse motion, with neither end raised from the side forms during the process. A slight amount of excess concrete shall be kept in front of the front edge at all times. When striking off and consolidating by hand, pours will be limited to single lanes or 1/4 of intersections.
- F. After striking off and consolidating, the surface shall be made uniform by longitudinal or transverse floating by a mechanical method unless the pavement is permitted to be constructed in single lane widths.
- G. Where mechanical floating is an integral part of the operation of a slip-form paver, separate mechanical floating methods will not be required.
- H. Mechanical longitudinal floating will not be required for residential street construction.
- I. When mechanical equipment is not used for floating, a transverse float at least 10 feet (3 m) in length shall be operated across the pavement by starting at the edge and slowly moving to the center and back again to the edge. The float shall then be moved ahead 1/2 of its length and the operation repeated.
- J. Care shall be taken to preserve the crown and cross section of the pavement. Float finishing operation shall not proceed until the concrete has attained a consistency so that no excess concrete is carried ahead of the float but the entire surface can be floated and sealed.

- K. Immediately following the float finishes and while the concrete is still plastic, CONTRACTOR shall test the slab surface for trueness by means of a 10-foot (3 m) straightedge or acceptable float.
- L. The straightedge shall be placed at the center of the slab with the blade parallel to the centerline and pulled slowly and uniformly to the edge. This operation shall be repeated until the surface of the concrete is free from irregularities and makes contact at all points with the bottom of the straightedge. The straightedge shall then be moved forward 1/2 its length and the operations repeated.
- M. Depressions found in the surface shall be filled with fresh concrete and consolidated by floating with a long-handled float not less than 10 feet (3 m) in length. Float may also be used to smooth sections of the surface that may have become rough or torn by dragging with the straightedge.
- N. For pavement constructed by the slip-form method, the edge settlement shall be determined as soon as practical after paving operations begin. Edge settlement in excess of 3/8 inch (9 mm) shall be corrected before the concrete has hardened. When edge settlements in excess of 1/4 inch (5 mm) persist, paving shall be suspended and operational corrections made before ENGINEER will permit the resumption of paving. If CONTRACTOR consistently fails to construct pavement within these tolerances, the use of slip-form methods shall be discontinued and pavement placed by means of conventional forms. When paving is accomplished by the slip-form paving method, all mortar paste shall be wiped from the sides of the slab.
- O. The surface shall then be tested for smoothness with the straightedge. During this operation, the contact of the straightedge with the concrete shall be uniform over the entire length tested. At the time of testing, the surface shall be free from soft mortar or excessive water. The testing straightedge shall be used for this purpose only.
- P. Where the float finisher method is not utilized, as soon as the hand floating is completed, all laitance, surplus water, and inert material shall be worked entirely off the pavement and the surface made smooth by dragging with a rigid straightedge 10 feet (3 m) in length and the surface shall be tested.
- Q. As soon as all excessive moisture has disappeared and while it is still possible to produce a uniform surface of gritty texture, the pavement shall be finished by dragging a seamless strip of damp burlap or cotton fabric, not less than 5 feet (1.5 m) nor more than 6 feet (1.8 m) in width, over the full width of the pavement. Burlap or cotton drag shall be pulled by a bridge supported on a pavement forms. Fabric shall be renewed as often as necessary to obtain the required texture.
- R. Immediately after the initial finishing with burlap, the edges of the slab and all specified joints shall be finished with an edging tool to the radii indicated on the Plans. Pavement shall then be given a final finish by dragging the damp burlap or cotton fabric over that portion of the pavement disturbed by the edging operation.

3.13 Surface Requirements

- A. High spots in the surface, exceeding 1/8 inch (3 mm) from the straightedge but not more than 1/2 inch in 10 feet (10 mm in 3 m) shall be removed or reduced by rubbing with a carborundum brick and water until contact with coarse aggregate is made.

1. If contact with coarse aggregate is made before reaching an acceptable tolerance, such high spots shall be removed by an approved surface-grinding machine before acceptance of the pavement.
- B. High spots in excess of 1/2 inch in 10 feet (10 mm in 3 m) will be evaluated by ENGINEER and if the Work is rejected, it shall be removed and replaced at CONTRACTOR's expense. CONTRACTOR shall take immediate steps to eliminate the cause of the defective surface.

3.14 Curing

- A. After the finishing operations have been completed and immediately after the free water has left the surface, the surface of the slab shall be completely coated and sealed with a uniform layer of white membrane curing compound.
- B. Compound shall be applied in a continuous uniform film by means of mechanically pumped pressure sprayer equipment at a rate of 1 gallon per 200 square feet (4 L per 20 m²) of surface. Curing compound shall not be thinned. The equipment shall provide adequate stirring of the compound during application. Equipment for applying the compound must be on the Project and approved by ENGINEER before Work is started.
- C. Hand-spray equipment will be permitted only for the application of the curing compound over the sides of the slab, and for any minor damaged areas. If rain falls on the newly coated pavement before the film has dried sufficiently to resist damage, or if the film is damaged in any other way, CONTRACTOR will be required to apply a new coat of material to the affected areas. The treated surface shall be protected by CONTRACTOR from injury for a period of at least 7 days. Traffic, either foot or otherwise, will be considered as injurious to the film of the applied compound. A minimum of foot traffic will be permitted on the dried film as necessary to properly carry on the Work including the removal of any high spots, provided any damage to the film is immediately repaired by the application of a second coat of the compound.
- D. Immediately after the forms are removed, the entire area of the side of the slab shall be coated with the curing compound at the rate specified for the pavement surfacing.
- E. CONTRACTOR shall provide on the Project sufficient burlap or polyethylene coverings for the protection of the pavement in case of rain or breakdown of the spray equipment. Failure to provide proper curing will be considered as sufficient cause for immediate suspension of the concreting operations.

3.15 Removal of Forms

- A. Forms may be removed from freshly placed concrete after it has set for 12 hours, provided it can be done without damage to the pavement or curb edge.
 1. If during form removal the pavement or curb edge is being damaged, the form removal shall cease until the concrete has attained greater strength.
 2. The period of time for removing forms may be increased or decreased when approved by ENGINEER.
- B. Immediately after removal of the forms, the ends of all joints shall be cleaned, and any visible areas of honeycomb or minor defects shall be filled with mortar, composed of 1-part Portland cement and 2 parts fine aggregate from the same source as used in the pavement, applied with a wooden float.

1. Immediate steps shall be taken by CONTRACTOR to correct the conditions contributing to these defects.
 2. The sides of the pavement shall be sprayed with curing compound immediately upon removal of the forms, except where honeycombed areas are to be pointed, and them immediately cured.
- C. Forms and pins shall not be placed on new pavement that is being cured with membrane.

3.16 Sawing Joints

A. General:

1. Contraction joints, longitudinal lane-tie joints with tie bars, and end of pour joints shall be sawed.
2. Joints shall be sawed before any traffic is permitted on the pavement. The concrete saw will be permitted on the pavement to saw the joints, but the water supply truck will not be permitted on the pavement until the compressive strength is not less than 3,000 psi (21 MPa). When permitted on the pavement, the water supply truck must be kept a minimum of 50 feet (15 m) behind the sawing operation. At least two (2) approved concrete saws shall be available for use at all times, and one saw shall be capable of sawing a joint groove 2-1/2 inches (65 mm) deep.
3. The saw cut for transverse end-of-pour joints shall be made to receive the joint sealing material.
4. Longitudinal lane-tie joints with the tie bars shall be sawed in accordance with the alignment and dimensions indicated on the Plans.
5. For joints formed in one operation, the joint groove shall be sawed before any transverse cracks develop. Raveling or spalling along the joint shall be repaired as specified in Article 3.17 of this Section.

B. Transverse contraction joints shall be sawed in two stages:

1. Stage 1 Sawing:
 - a. The first stage shall be a relief cut directly over the center of the load transfer assembly. The initial relief cut shall be made as soon as the saw can be placed on the freshly poured concrete, and the sawing shall continue as long as the pavement can support the saw without making or appreciably raveling of the joint.
 - b. When water is not used in the sawing operation, membrane curing compound shall be applied immediately.
 - c. When water is used in the sawing operation, the slurry resulting from the sawing operation shall be completely removed from the cut and from the immediate area by flushing with a jet of water. Additional membrane curing compound shall be applied within 12 hours after the relief cut has been made.

C. Stage 2 Sawing:

1. Second stage sawing of joints shall not start until the concrete has cured for a minimum of 48 hours. The joint groove shall be centered over the relief cut and sawed to the specified dimensions shown on the Plans plus any increase in width of the relief cut due to shrinkage or contraction. The groove width tolerance shall be $\pm 1/16$ inch (2 mm).
2. Joints sawed without the use of water shall be blown clean of all foreign material by a jet of compressed air.
3. If water was used in the sawing operation, the slurry resulting from the sawing operation shall be completely removed from the groove and the immediate area by flushing with a jet of water and then blown dry with compressed air.
4. Transverse joint grooves shall receive a final cleaning with a jet of compressed air adequate to remove all foreign material, just prior to permanent sealing.
5. If the specified seal is not installed within seven days of final sawing, the joint groove shall be temporarily sealed with a suitable material or device to prevent the infiltration of foreign material.
6. Traffic shall not be permitted over the full width joint grooves prior to the installation of either the permanent seal or temporary seal.

3.17 Patching Joints

A. General:

1. After the joints have been sawed and cleaned, they shall be inspected for spalls and voids.
2. Loose, unsound or damaged concrete shall be removed to the satisfaction of ENGINEER.
3. Spalls and voids will be classified as minor, intermediate or major spalls and shall be repaired accordingly.

B. Minor Spalls:

1. Spalls or voids which have increased the specified size of the joint groove beyond any of the following limits, but less than 36 square inches (250 cm²), shall be repaired by patching with an approved epoxy mortar before the seal is installed.
2. Spalls which extend more than 1/4 inch (5 mm) from the joint face and over 1/2 inch (10 mm) below the surface of the pavement.
3. Spalls which extend more than 1/4 inch (5 mm) from the joint face and two (2) inches (50 mm) or more in length, regardless of the depth of spall below the surface of the pavement. Void areas larger than 1/2 inch (10 mm) in diameter in the upper 1-inch (25 mm) of the joint face or larger than 1-inch (25 mm) in diameter regardless of location.

4. Spalled concrete surface shall be thoroughly cleaned by sandblasting, power-wire brushing, or hand-wire brushing. The patch area shall then be blown clean with a jet of compressed air. A heavy polyethylene sheet or a rigid material shall be inserted into the joint groove and held tightly against the joint face that is to be patched.
5. Concrete shall be clean and dry when the epoxy resin mortar is placed. The surface shall be made free of frost by heating with a clean source of heat, approved by ENGINEER, until dry. Care shall be taken not to damage the concrete by heating.
6. Epoxy binder will be a mixture of 2 parts epoxy resin to 1 part curing agent by volume, or as approved by ENGINEER.
7. Epoxy resin compound shall be mixed in a clean metal or polyethylene container with approved stirrer operating at 250 to 500 rpm. While the epoxy resin is being mixed, the curing agent compound shall be gradually added. The mixture shall then be stirred for a minimum of 3 minutes until it is uniform.
8. After the epoxy binder is thoroughly mixed, a small portion shall be reserved for priming. The dry 2MS sand shall be uniformly blended into the balance of the mixture to give an epoxy mortar of stiff or trowellable consistency. One part of mixed binder to about 3.5 parts of dry sand, by volume, will usually give a workable mix.
9. Spalled surface shall be primed with the freshly mixed epoxy binder scrubbed into the surface with a suitable applicator to insure complete wetting and coverage of all areas to which the epoxy mortar must bond.
10. Immediately after priming, the epoxy mortar shall be placed in the spalled area and finished to the shape of the original pavement surface. If the bond coat is not tacky when the mortar is placed, a second application shall be made. The edge of the patch shall conform with the rest of the joint groove. Dry 2NS sand shall be sprinkled onto the fresh epoxy mortar surface to eliminate any gloss. After the epoxy mortar has cured sufficiently so that it will not be damaged during sealing operations, the polyethylene insert shall be carefully removed. Joints shall receive a final cleaning with a jet of compressed air to remove all foreign material.
11. When the temperature of the air and the pavement is above 50 degrees Fahrenheit (10° Celsius), the hot poured elastic type joint seal may be placed on the day following the placing of the epoxy resin mortar patch. When the temperature of the air and the concrete is below 50 degrees Fahrenheit (10° Celsius), the time of curing required for the epoxy mortar shall be as determined by ENGINEER.

C. Intermediate Spalls:

1. Spalls larger than 36 square inches (250 cm²), but not extending below the reinforcing mat, shall be repaired by sawing and chiseling out the unsound concrete and patching with Portland cement mortar.

2. A saw cut at least 1-inch (25 mm) deep shall be made parallel to the joint groove at the outer extremity of the spalled area. The concrete shall be chipped out to the saw cut so that a vertical face is present at the back of the repair area, and the two ends of the repair area shall be trimmed to approximately vertical faces.
3. The area to be repaired shall be sandblasted to remove all loose particles and then blown clean with a jet of compressed air to remove the sand and all other foreign materials. The repair area shall be flushed with clean water and the excess water shall be blown out with compressed air.
4. A heavy polyethylene sheet or a rigid material shall be inserted into the joint groove and held tightly against the joint face that is to be patched.
5. The bottom and vertical faces of the repair area shall be primed with a grout of creamy consistency made with a 1:1 mixture of Portland cement and 2NS sand with water.
6. Prime coat will be scrubbed into the surface with a suitable applicator to insure complete wetting and coverage of all areas to which the Portland cement mortar must bond. Cement grout shall be carefully applied to the rough surfaces of the spall area and shall be applied immediately prior to placing of fresh mortar so that the prime coat is wet when covered by mortar.
7. Portland cement patching material shall be tamped into the repair area and finished level to the pavement surface. Portland cement mortar shall consist of 1-part Portland cement 2 parts 2NS sand with a water content of not more than four (4) gallons per sack of cement (35 L per 100 kg of cement). A liquid air-entraining agent to maintain an air content of 8% to 11% shall be added. Calcium chloride in an amount of 1 percent of the cement content may be added as an accelerator, if approved by ENGINEER.
8. The edge of the patch at the joint face shall conform with the rest of the joint groove.
9. White membrane curing compound shall be sprayed on the patch surface immediately after the mortar is cast and finished. After 72 hours the polyethylene form shall be carefully removed and all patched joints shall receive a final cleaning with a jet of compressed air to remove all foreign material.

D. Major Spalls:

1. When a joint is damaged beneath the depth of the reinforcing mat, it shall be considered a major repair. These major repairs shall be handled on an individual basis under the direction of ENGINEER.

3.18 Sealing Joints

- A. Transverse expansion, contraction, construction, and longitudinal bulkhead construction joints shall be filled and sealed with an approved hot-poured elastic type compound.
- B. Longitudinal lane-tie joints shall be pressure filled and sealed with either an approved hot-poured or cold-applied elastic type compound. These sealing compounds shall not be placed when the atmospheric or pavement temperatures are less than 50° Fahrenheit (10° Celsius) or when the weather is rainy or foggy.

- C. After the shoulders are completed and the pavement has cured, the joints and pavement surfaces on each side of the joints shall be cleaned of extraneous matter. The cleaning shall be done by sandblasting or other methods approved by ENGINEER that will be equally effective in cleaning the concrete. The dust and sand present after the sandblasting or cleaning shall be removed by a jet of compressed air. Hand tools shall be used to remove stones and other foreign materials from the joint groove.
- D. Immediately after the joints are cleaned with the compressed air, and with the surface of the concrete in the joint dry, the joint shall be sealed with an approved hot-poured elastic type compound.
- E. The hot-poured compound shall be melted in an approved double boiler type kettle. Direct heating will not be permitted. Also, any sealing material heated in excess of the safe heating temperature shall not be used in the Work.
- F. During the process of pouring the joints, ENGINEER may, at his discretion, require that sufficient compound be taken from the melting unit to make flow tests. ENGINEER may require CONTRACTOR to modify his method of heating or of charging the heating unit with compound that will produce satisfactory results.
- G. Pouring shall be from the melting kettle equipped with an approved pressure pump hose and nozzle. When authorized by ENGINEER, the sealing compound may be poured with a hand-type pouring pot for curbs and short miscellaneous joint lengths, provided a satisfactory joint is obtained.
- H. Pouring of the sealing compound shall be done so as to fill the joint to 1/4 inch (5 mm) below top of pavement. Sealing compound spilled on the surface of the pavement shall be removed immediately. After the first pour has cooled to the temperature of the pavement and settled, a second pour shall be made to bring the sealing compound to 1/4 inch (5 mm) of the surface of the pavement. Traffic shall not be permitted over the poured joint until the compound has hardened sufficiently to resist pickup.
- I. Longitudinal lane-tie joints shall be cleaned and immediately filled with either an approved hot-poured or cold-applied elastic type compound. Sealing compounds shall be applied with pressure equipment, capable of completely filling the joint.
- J. To protect hot-poured and cold-applied sealing compound while it is curing and to prevent pickup by traffic, the sealed joint shall be covered with a strip of paper, 1-1/2 inches (40 mm) wide, or other approved means, immediately following application of the compound. The paper strip shall be left in place until worn off by traffic.

3.19 Traffic Control

- A. Provide all measures necessary to protect and maintain traffic and to protect the Work in accordance with Section 01 5000, Temporary Facilities Controls, and with the Michigan Manual of Uniform Traffic Control Devices (M.M.U.T.C.D.).

3.20 Protection against Rain

- A. CONTRACTOR shall adequately protect the new concrete from the effects of rain before the concrete has sufficiently hardened.
 - 1. For this Work, CONTRACTOR shall have available on the job site at all times enough burlap or 6-mil (150 µm) thick polyethylene film to cover and protect one day's Work.

- B. When rain appears eminent, all operations shall stop and personnel shall begin covering. As soon as the rain ceases, the concrete shall be uncovered and the surface burlap dragged where necessary.
- C. Curing compound shall be applied to any areas where the compound has been disturbed or washed away. Protection of the new concrete against rain shall be at CONTRACTOR's expense.

3.21 Cold Weather Protection

- A. Any time there is a danger of freezing temperatures, CONTRACTOR shall have available on-site a sufficient amount of clean, dry straw or hay or polyethylene film or other approved materials to cover at least 1 day's production. Cold weather protection shall be at CONTRACTOR's expense.
- B. The source of the temperature shall be taken from forecasts prepared by the local weather bureau, recognized as the Official Weather Bureau for the area the new Work is being constructed. The predicted low temperature shall be that forecast to occur during the next 24 hours.
- C. Frozen material shall not be charged into the mixer at any time.
- D. Frost or ice shall be removed from the forms and any steel used in the pavement, prior to placing concrete.
- E. Concrete shall not be placed directly upon a frozen subgrade. The subgrade shall be covered with a layer of straw or hay 12 inches (300 mm) in thickness to protect it against freezing. The straw or hay shall be removed from the finished subgrade immediately ahead of paving operations and piled along the line of construction for use in covering the finished pavement. Prior to the placing of concrete, the subgrade shall be cleaned of loose straw and otherwise prepared in a manner satisfactory to ENGINEER. Other covering materials as approved by ENGINEER may be used to prevent subgrade freezing.
- F. To accelerate hardening of the concrete when the temperature of the air in the shade and away from artificial heat is between 45 and 40 degrees Fahrenheit (7° to 4° Celsius), calcium chloride shall be added to the mix at the rate approved by ENGINEER. The calcium chloride shall be spread on the materials immediately before discharging into the drum of the mixer. A method approved by ENGINEER, shall be used for measuring the amount of dry calcium chloride to be added to each batch of concrete. The calcium chloride shall not be placed in contact with the cement.
- G. Immediately after finishing of the concrete and as soon as hardening of the concrete will permit, the pavement shall be covered and the protective covering shall remain in place until the concrete has developed a compressive strength of not less than 3,000 pounds per square inch (21 MPa) or for a minimum period of 14 days or as approved by ENGINEER.
- H. The protective covering shall be placed around and over the forms and it shall extend beyond the edge of the pavement for a distance at least equal to the depth of covering required.
- I. When removing forms, the protective covering should be removed for as short a time as possible and should be replaced promptly to prevent loss of heat.

- J. The mixing and placing of concrete shall stop in sufficient time each day to permit finishing of the concrete and the placing of the required protective covering during daylight hours.
- K. The requirements specified herein for the curing and protection of concrete in cold weather are minimum requirements, and CONTRACTOR shall be responsible for the quality and strength of the concrete placed. Concrete damaged by frost action shall be removed and replaced at CONTRACTOR's expense.
- L. Between October 15 and May 15, when the predicted low temperature is to be below 35 degrees Fahrenheit (2° Celsius) at any time within 72 hours after placing the pavement, the pavement shall be protected and such protective covering shall remain in place until the concrete has developed a compressive strength of not less than 3,000 psi. (21 MPa), or for a minimum period of 14 days, unless otherwise authorized by ENGINEER.
- M. Special Protection:
1. No pavement may be placed between October 15 and May 15, unless it is specifically provided for in the Contract Documents, or authorized by ENGINEER, except that in no case shall concrete be placed when the predicted high temperature is to be below 35 degrees Fahrenheit (2° Celsius), without written permission of ENGINEER. When paving is permitted during the period, the following requirements shall apply:
 2. The temperature of the concrete at the time it is placed on the subgrade shall be not less than 50 degrees Fahrenheit (10° Celsius), nor more than 85 degrees Fahrenheit (30° Celsius).
 3. In order to maintain a mix temperature between 50 degrees Fahrenheit (10° Celsius) and 85 degrees Fahrenheit (30° Celsius) the mixing water or the aggregates, or both, shall be heated as required by ENGINEER. The water and the aggregates shall be heated to a temperature of not more than 150 degrees Fahrenheit (65° Celsius). The heating of aggregates shall be done by the use of steam pipe under the aggregate piles, or by free steam discharged into the aggregate piles, or by steam pipe in the batching bins. The heating of the water and the aggregates shall be controlled so that there will not be any large differences in temperature from batch-to-batch.
 4. When there is any danger of the predicted low temperature dropping below 35 degrees Fahrenheit (2° Celsius) all the necessary materials for covering and protecting the concrete, equipment for heating the water and aggregates, when required, and calcium chloride shall be on the Project and available for immediate use for the required method of curing and cold weather protection before any pavement is placed.
 5. For predicted low temperatures from 35 to 25 degrees Fahrenheit (2 to -4° C) either 1-layer of waterproof paper blankets or 1-foot (300 mm) of loose dry straw or hay shall be placed.
 6. For predicted low temperatures of 20 to 25 degrees Fahrenheit (-7 to -4° Celsius) 1-layer of waterproof paper blankets and 1-foot (300 mm) of loose dry straw or hay shall be placed.

7. For predicted low temperatures less than 20 degrees Fahrenheit (-7° Celsius) the minimum requirement for cold weather protection will be 1-layer of waterproof paper blankets and 1-foot (300 mm) of loose dry straw or hay overlaid with a waterproof protective covering consisting of tarpaulins, paper blankets, polyethylene sheeting or other approved material.
- N. When temperature are such that special protection is required as specified above, all concrete placed within the proceeding 72 hours shall be similarly protected.
- O. When special protection is started, it shall be continued until design strength is reached in accordance with the above requirements unless warmer temperatures prevail for a period of at least 48 hours. Permission to eliminate special protection for such a period shall be as approved by ENGINEER.
- P. Protection of the new concrete against cold weather including ordinary and special protection shall be at CONTRACTOR's expense.

3.22 Concrete Temperature Limitations

- A. Concrete shall not be placed when the temperature of the concrete at the point of placement is above 90 degrees Fahrenheit (32°Celsius).

3.23 Curb Drop

- A. Curb drops shall be provided for existing and future sidewalk ramps, for approaches for existing driveways and at other locations as determined by ENGINEER.
- B. Curb drops for sidewalks shall be in accordance with the current rules and regulations of Act 8, Michigan PA 1973, as amended. Curb drops for drive approaches shall be centered with the existing driveway at the property line.
- C. Width of the residential curb drop shall be equal to the width of the driveway determined at the property line plus four feet. Unless otherwise approved by ENGINEER, the minimum width of the residential curb drop shall be 14 feet (4.5 m).

3.24 Shoulders

- A. Shoulders shall be constructed according to the lines, grades, and cross section shown on the Plans and as specified for the particular type of shoulder material required. Shoulders shall be done in such sequence with the surfacing operations that they will be completed not more than seven (7) days after the expiration of the curing period, unless otherwise directed by ENGINEER.
- B. Aggregate shoulders, when called for, shall be constructed according to the requirements specified under Section 32 1123, Aggregate Base Courses.

3.25 Cleanup

- A. After the concrete has gained sufficient strength, but no sooner than within 12 hours, the fixed forms shall be removed and the spaces on both sides shall be immediately backfilled with sound earth of topsoil quality.
- B. Backfill shall be compacted, leveled and left in a neat, workmanlike condition.

- C. At a seasonally correct time approved by ENGINEER, the disturbed area shall be raked, have topsoil placed thereon, fertilized and seeded per the requirements of Section 32 9219, Seeding, or sodded in accordance with Section 329223, Sodding.

3.26 Opening Pavement

- A. ENGINEER reserves the right to require that curing operations be discontinued when the concrete has reached 85% of the design strength, and to require that the shoulders be completed and the slab be opened to traffic.

3.27 Monument Boxes

- A. Government, plat, and street intersection monuments within existing or proposed pavement shall be preserved by enclosing in standard monument boxes. Monument box castings shall be furnishing and installed by CONTRACTOR.
- B. Existing monument boxes shall be adjusted to meet the proposed pavement elevation by removing the castings and resetting to the required elevation.
- C. Support for the monument box shall be concrete bedding, so constructed as to hold them firmly in place.
- D. The adjacent pavement, curb, or curb and gutter shall be replaced to the new elevation, condition and kind of construction, unless otherwise provided.

3.28 Testing

- A. During the course of the Work, ENGINEER may require the taking of standard test scores and cylinders, by a testing laboratory acceptable to OWNER and approved by ENGINEER. Cost of testing and coring shall be at the expense of OWNER.
- B. For each lane of Work:
 - 1. A minimum of one (1) cylinder for testing compressive strength shall be made for each 500 linear feet (150 m), or fraction thereof, or as determined by ENGINEER.
 - 2. A minimum of two (2) cores for testing compressive strength and for checking thickness shall be drilled each 500 feet (150 m), or fraction thereof.
 - 3. The making of cylinders, the drilling of cores and testing shall be at the expense of OWNER.
- C. Slump tests for consistency of Portland cement concrete shall be made in accordance with ASTM C143 and C172.
- D. In the event the test results on a core indicates a deficiency in either thickness or compressive strength or in the event the test results on a cylinder indicates a deficiency in compressive strength, the following adjustments in the unit price for concrete shall be made based on the average of 3 cores:

Thickness	
Under Required Thickness	Percent of Reduction in Unit Price
0" to 1/4"	None
by more than a 1/4", but not exceeding a 1/2"	20
by more than a 1/2", but not exceeding 1"	50
by more than 1"	Remove & Replace

Comprehensive Strength	
Under Required Compressive Strength	Percent of Reduction in Unit Price
0 to 150 psi (0 to 1 MPa)	None
by more than 150 psi, but not exceeding 300 psi (1 MPa to 2 MPa)	20
by more than 300 psi, but not exceeding 500 psi (2 MPa to 3.5 MPa)	50
by more than 500 psi (Greater than 3.5 MPa)	Remove & Replace

- E. Reduction in the unit price are additive, that is if an area is deficient by 3/8 of an inch (9 mm) and is under strength by 200 psi (1.4 MPa), the total reduction is 20% plus 20% or a reduction of 40%.
- F. The area of a deficient core shall be determined by the drilling and testing of two (2) additional cores, one (1) on each side of the deficient core and 20 feet (6 m) from it, when possible.
- G. The extra core drilling and testing shall be at CONTRACTOR's expense.

End of Section

Section 32 1315 Sidewalks and Driveways

Part 1 General

1.01 Scope of Work

- A. This Section includes sidewalks, sidewalk ramps, driveways, and drive approaches complete with concrete materials, concrete curing compounds, joint materials, field quality control and appurtenances.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200: Unit Prices
- B. Section 31 1100: Clearing and Grubbing
- C. Section 31 2313: Subgrade Preparation
- D. Section 32 9219: Seeding
- E. Section 32 9223: Sodding

1.03 Reference Standards

- A. Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. ASTM - American Society of Testing and Materials
 - 2. AASHTO - American Association of State Highway and Transportation Officials
 - 3. MDOT - Michigan Department of Transportation, Standard Specifications for Construction, latest edition

1.04 Submittals

- A. Written permission for the use of all local disposal sites shall be obtained and copies shall be furnished to ENGINEER.
- B. At the request of ENGINEER, CONTRACTOR shall provide ENGINEER with certification that the various materials to be used conform to the ASTM Standards referred to in the Specification.

1.05 Test Reports

- A. ENGINEER shall be provided with two (2) certified copies of the test results of the thickness and compressive strength of the concrete. Core drilling, testing for thickness and compressive strength and the certification of the test results shall be performed by a testing laboratory approved by ENGINEER.

1.06 Environmental Requirements

- A. Comply with the requirements for concrete installation due to outside ambient air temperatures specified under Article 3.11 of this Section.

1.07 Protection

- A. Comply with the requirements for protecting new Work against damage from rain, as specified under Article 3.11 of this Section.
- B. Comply with the requirements for protecting new Work against damage from cold weather, as specified under Article 3.11 of this Section.

Part 2 Products

2.01 Concrete

- A. Concrete shall be in accordance with MDOT Section 601 or 701, use Grade P1 or S2, 3,500 psi (24 MPa) strength; Type IA cement; 6.0 sacks cement per cubic yard (335 kg/m³); 6A coarse aggregate; 2NS fine aggregate; 6.5% ± 1.5% air content; 3-inch (75 mm) maximum slump; no admixtures without ENGINEER's approval. Type IIIA cement may be used for high-early strength concrete.

2.02 Ready-Mixed Concrete

- A. Ready-mixed concrete shall conform to ASTM C94, Alternate 2.

2.03 Water

- A. Water to be used for mixing and curing concrete shall be reasonably clean and free from oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product. Waters from sources approved by the Michigan State Department of Public Health as potable may be used without test. Water requiring testing shall be tested in accordance with the current Method of Test for Quality of Water to be Used in Concrete, AASHTO T26, and as specified in MDOT Section 911.

2.04 Concrete Curing Compounds

- A. White membrane curing compound for curing concrete shall conform to ASTM C309, Type 2, Class B Vehicle, and as specified in MDOT, Section 903.

2.05 Premolded Joint Filler

- A. Fiber joint filler for expansion joints shall conform to ASTM D1751. Filler shall be of the thickness, as specified herein, or on the Plans, or as approved by NGINEER.

2.06 Steel Hook Bolts

- A. Hook bolts shall conform to ASTM A706, or Grade 60 of ASTM A615, A616-96a, or A617-96a. Hook bolts shall be 5/8-inch (16 mm) diameter.

2.07 Joint Sealant

- A. Hot-poured type joint sealant shall conform to ASTM D6690 Type II and as specified in MDOT Section 914.

2.08 Concrete Mix

- A. Concrete shall contain a minimum of six sacks, 94 pounds per sack, of cement per cubic yard (335 kg/m³) and shall yield a minimum compressive strength of 3,500 psi (24 MPa) at 28 days.

- B. Cement shall be air-entraining Portland cement ASTM C150, Type 1A. If high-early strength concrete is desired, Type IIIA is required.
- C. High-early concrete can be obtained for small areas by the addition of one sack of cement, Type 1A, per cubic yard of concrete (56 kg/m³).
- D. The air content of the concrete shall be 6.5%± 1.5% by volume.
- E. Maximum slump of the concrete shall be three (3) inches (75 mm).
- F. Ready-mixed concrete in accordance with ASTM C94, Alternate 2, shall be used, unless a written request for other than ready-mixed concrete has been submitted, reviewed and approved by ENGINEER.

Part 3 Execution

3.01 Verification of Excavation and Forming

- A. Prior to the installation of any concrete, examine the excavation and forms for the proper grades, lines, and levels required to receive the new Work. Ascertain that excavation and compacted subgrades are adequate to receive the concrete to be installed.
- B. Correct all defects and deficiencies before proceeding with the Work.

3.02 Existing Improvements

- A. Investigate and verify location of existing improvements to which the new Work is to be connected.
- B. Adjustments in line and grade to align the new Work with the existing improvements must be approved by ENGINEER, prior to any change.

3.03 Forming

- A. Forms shall be of wood or metal, straight and free from warp, clean, and of sufficient strength to resist springing during the process of depositing concrete against them.
- B. Forms shall be the full depth of the concrete.

3.04 Sidewalks, Sidewalk Ramps, Driveways, and Driveway Approaches

- A. Unless otherwise noted in the Contract Documents, all sidewalks and sidewalk ramps shall be four (4) inches (100 mm) thick except at driveways, where the thickness of the sidewalks shall be six (6) inches (150 mm).
- B. Sidewalks shall be five (5) feet (1.5 m) wide unless otherwise noted on Plans, and shall slope 1/4 inch per foot (20 mm/m) towards the surface drainage side which in general will be towards the center of the road.
- C. Normally sidewalks will be located within the right-of-way, parallel the property lines, at a distance of 1-foot (300 mm) from the property line.
- D. Driveways and approaches shall be six (6) inches (150 mm) thick. The width of driveways and driveway approaches shall be as specified on the Plans or as determined by ENGINEER.

3.05 Remove Curb for Curb Drop

- A. Construction of sidewalk ramps within street intersections where curbed pavement exists shall conform to the current rules and regulations of Act 8, Michigan PA 1973.
- B. Where there is no proper curb drop for the sidewalk ramp or driveway approach, CONTRACTOR shall saw cut, to full depth of pavement, and remove a minimum of an 18-inch (450 mm) wide curb and gutter section. When mountable curbs are present, CONTRACTOR shall remove a 24-inch (600 mm) wide curb and gutter section for the construction of sidewalk ramp, as specified above.
- C. Length of curb and gutter removal shall be determined by ENGINEER in the field but shall be at least as wide as the proposed sidewalk ramp plus 1-foot (300 mm) on each side.
- D. Removed curb and gutter section shall be replaced with material, equal to what was removed and the joint sealed with hot poured rubber asphalt.
- E. CONTRACTOR shall install 5/8-inch (15 mm) diameter self tapping hook bolts, in the existing concrete pavement as indicated on the Plans prior to placing concrete for the removed curb and gutter section.
- F. Curbs may be cut or ground down with an approved concrete grinder when the final results will leave the cut or ground down curb in a smooth, clean condition acceptable to ENGINEER. Curbs that are cut or ground down that are not acceptable to ENGINEER, shall be removed and replaced as specified above at no additional cost.

3.06 Placement of Forms

- A. Wood forms, straight and free from warp, of nominal depth may be used for sidewalk sections less than 25 feet (7.5 m) in length.
- B. Forms shall be staked to line and grade in a manner that will prevent deflection and settlement.
- C. When unit slab areas are to be poured, slab division forms shall be so placed that the slab division joints will be straight and continuous.
- D. Forms shall be set for sidewalk ramps to provide a grade toward the centerline of the right-of-way in accordance with current standards. The grade shall be uniform, except as may be necessary to eliminate short grade changes.
- E. Forms shall be oiled before placing concrete. Forms shall remain in place at least 12 hours after the concrete is placed. There shall be sufficient forms placed ahead of the pouring operations to maintain uninterrupted placement of concrete.
- F. The use of slip form pavers can be allowed when approved by ENGINEER in lieu of the construction system described above.

3.07 Joints

- A. Transverse and longitudinal expansion and plane-of- weakness joints shall be constructed at the locations specified herein, or as indicated on the Plans or as approved by ENGINEER.

- B. Transverse expansion joints shall be placed for the full width and depth of the new Work. The transverse expansion joints placed against any existing pavement shall be a minimum of 6 inches (150 mm) deep but no less than the thickness of the concrete being placed.
- C. Longitudinal expansion joints shall conform to the same requirements as transverse expansion joints.
- D. Joints shall be constructed true to line with their faces perpendicular to the surface of the sidewalk. The top shall be slightly below the finished surface of the sidewalk. Transverse joints shall be constructed at right angles to the centerline of the sidewalk and longitudinal joints shall be constructed parallel to the centerline or as determined by ENGINEER.
- E. Unless otherwise specified on the Plans or unless otherwise determined by ENGINEER, when the sidewalk is constructed in partial width slabs, transverse joints in the succeeding slabs shall be placed in line with like joints in the adjacent slab. Also, in the case of widening existing sidewalks, transverse joints shall be placed in line with like joint in the existing sidewalk.
- F. Transverse expansion joints, 1/2 inch (10 mm) thick, shall be placed through the sidewalk at uniform intervals of not more than 50 feet (15 m) and elsewhere as shown on the Plans, or as determined by ENGINEER.
- G. Expansion joints, 1/2 inch (10 mm) thick, shall also be placed between the sidewalk and back of abutting parallel curb, buildings or other rigid structures, concrete driveways and driveway approaches. The expansion joint between sidewalks and buildings shall be placed 1-foot from the property line and parallel to it.
- H. Expansion joints, 1-inch (25 mm) thick, shall be placed between sidewalk ramps or driveway approaches and the back of curbs.
- I. Plane-of-weakness joints shall be formed every 5 feet (1.5 m) and shall be produced by use of slab divisions forms extending to the full depth of the concrete or by cutting joints in the concrete, after floating, to a depth equal to 1/4 the thickness of the sidewalk. Cut joints shall not be less than 1/8 inch (3 mm) nor more than 1/4 inch (5 mm) in width and shall be finished smooth and shall be at right angles to the centerline of the sidewalk.

3.08 Placing and Finishing Concrete

- A. Concrete shall be placed on a prepared unfrozen, smooth, leveled, rolled and properly compacted base as indicated on the Plans. The surface of the subbase shall be moist with no visible water present prior to placement of the concrete.
- B. Concrete shall be deposited, in a single layer, to the depth specified in the Plans or in the Proposal. Concrete shall be thoroughly spaded or vibrated and compacted to fill in all the voids along the forms and joints. Concrete shall be struck off with a strike board until all voids are removed and the surface has the required grade and cross section as indicated on the Plans.
- C. The surface of the concrete shall be floated just enough to produce a smooth surface free from irregularities. All edges and joints shall be rounded with an edger having a 1/4-inch (5 mm) radius. The surface of sidewalks, driveways and approaches shall be broomed to slightly roughen the surface.

- D. The surface of sidewalk ramps shall be textured with a coarse broom transversely to the ramp slope. The texture on sidewalk ramps shall be coarser than the remainder of the sidewalk.

3.09 Curing

- A. After finishing operations have been completed and immediately after the free water has left the surface, the surface of the concrete (and sides if slip-forming is used) shall be completely coated and sealed with a uniform layer of white membrane curing compound.
- B. The curing compound shall not be thinned. The curing compound shall be applied at the rate of 1-gallon per 200 square feet (4 L per 20 m²) of surface.

3.10 Barricades

- A. Suitable barricades and lights shall be placed around all newly poured sidewalks, sidewalk ramps, driveways, driveway approaches and curb and gutter section in order to protect the new Work from damage from pedestrians, vehicles and others until the concrete has hardened.
- B. Barricades shall be left in place for a minimum of two (2) days, except for driveway approaches and curb and gutter section. Barricades shall remain in place for a minimum of three (3) days.
- C. Concrete that suffers surface or structural damage shall be removed and replaced by CONTRACTOR at his expense.

3.11 Protection

- A. CONTRACTOR shall adequately protect the new concrete from the effects of rain before the concrete has sufficiently hardened. For this Work CONTRACTOR shall have available on the job site at all times enough burlap or 6-mil thick polyethylene film to cover and protect one (1) day's work. When rain appears eminent, operations shall stop, and personnel shall begin covering. As soon as the rain ceases, the concrete shall be uncovered, and the surface burlap dragged where necessary. Curing compound shall be applied to any areas where the compound has been disturbed or washed away.
- B. If concrete is placed between October 15 and May 15, CONTRACTOR shall have available on the site sufficient amount of clean, dry straw or hay to cover one day's production. If the temperature reaches 40 degrees Fahrenheit (4 degrees Celsius) and is falling, the hay or straw shall be placed 12 inches (305 mm) thick, immediately after the curing compound is applied. If the temperature is 30 degrees Fahrenheit (-1 degrees Celsius) and falling the curing shall be by 6-mil thick polyurethane film placed on the concrete as soon as the surface moisture has disappeared, and then covered with 12 inches (300 mm) of straw or hay.
- C. Also, whenever the temperature in the shade falls below 50 degrees Fahrenheit (10 degrees Celsius), the water, sand and coarse aggregate shall be heated in that order sufficiently to maintain a uniform temperature of the concrete at between 70 degrees Fahrenheit and 80 degrees Fahrenheit (21 to 27 degrees Celsius).
- D. Concrete shall not be placed when the temperature of the concrete at the point of placement is above 90 degrees Fahrenheit (32 degrees Celsius).

3.12 Cleanup

- A. After the concrete has gained sufficient strength, but no sooner than within 12 hours, the fixed forms shall be removed and the spaces on both sides shall be immediately backfilled with sound earth of topsoil quality. Backfill shall be compacted, leveled and left in a neat, workmanlike condition.
- B. At a seasonally correct time approved by ENGINEER, the disturbed area shall be raked, have topsoil placed thereon, fertilized and seeded per the requirements of Section 32 9219, Seeding, or sodded in accordance with Section 32 9223, Sodding.

3.13 Testing

- A. ENGINEER may require that a minimum of two cores be drilled from the sidewalk for each 500 (or fraction thereof) linear foot (150 m) section placed. At least one (1) core out of two (2) required will be taken from the sidewalk at the driveway. One (1) core may be required from every 20 (or fraction thereof) of driveway approaches or sidewalk ramps installed.
- B. Cores shall be checked for depth and compressive strength. Core drilling and tests shall be done by a testing laboratory designated by OWNER and at the expense of OWNER. The testing laboratory shall furnish ENGINEER with two (2) certified copies of the test results.
- C. In the event the test results on a core indicates a deficiency in either thickness or compressive strength the following adjustments in the unit price for concrete shall be made:

Thickness	
Under Required Thickness	Percent of Reduction in Unit Price
0" to 1/4"	None
by more than a 1/4", but not exceeding a 1/2"	20
by more than a 1/2", but not exceeding 1"	50
by more than 1"	Remove & Replace

Compressive Strength	
Under Required Compressive Strength	Percent of Reduction in Unit Price
0 to 150 psi	None
by more than 150 psi, but not exceeding 300 psi	20
by more than 300 psi, but not exceeding 500 psi	50
by more than 500 psi	Remove & Replace

- D. The area of the deficient core shall be determined by the drilling and testing of two (2) additional cores, one (1) on each side of the deficient core and 20 feet (6 m) from it when possible. Extra core drilling and testing shall be at the expense of CONTRACTOR. Reductions due to deficiencies in thickness or compressive strength are additive, that is, if an area is deficient by 3/8 inch (9 mm) and under strength by 200 psi (1.3 MPa), the total reduction is 20% plus 20% or 40% reduction.

End of Section

Section 32 1500 Aggregate Surfacing

Part 1 General

1.01 Scope of Work

- A. This section includes the requirements for constructing aggregate surfacing.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200
- B. Section 01 8900
- C. Section 31 2313
- D. Section 32 1216
- E. Section 32 1313
- F. Section 32 9219

1.03 Reference Standards

- A. Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. ASTM – American Society of Testing and Materials
 - 2. AASHTO – American Association of State Highways and Transportation Officials
 - 3. MDOT – Michigan Department of Transportation, Standard Specifications for Construction, latest edition

1.04 Allowable Tolerances

- A. The finished surface shall be shaped to conform to plan grade and cross section within a tolerance of 3/4 inch in 10 feet (30 mm per 5 m).

1.05 Test Reports

- A. Testing lab shall provide ENGINEER with 2 certified copies of the test results of the thickness of the compacted aggregate. Core drilling, testing for thickness and certification of the test results shall be performed by a testing laboratory approved by ENGINEER.

1.06 Stockpiling Aggregate

- A. Aggregate shall be deposited in stockpiles in such a manner that the material may be removed from the stockpile by methods which will provide aggregate having a uniform gradation.
- B. Stockpiling of aggregate, in excess of 4 feet (1.2 m) in depth, on the completed subbase or aggregate surface will not be permitted, except with the approval of ENGINEER.

1.07 Environmental Requirements

- A. Comply with the requirements for aggregate base or surfacing installations due to outside ambient air temperatures specified under Article 3.10 of this Section.

Part 2 Products

2.01 Dense-Graded Aggregate

- A. The dense-graded aggregate gradation shall conform to dense-graded aggregate, Series 22 and 23 as specified in MDOT Section 902.

2.02 Calcium Chloride Additives

- A. The calcium chloride additives shall conform to ASTM D98 and as specified in MDOT Section 903.

2.03 Water

- A. Water used for compaction and dust control shall be reasonably clean and free from substances injurious to the finished product. Water from sources approved by the Michigan State Department of Public Health as potable may be used.

Part 3 Execution

3.01 Excavation Verification

- A. Prior to the placing of any aggregate material, examine the excavation for the grades, lines, and levels required to receive the new Work. Ascertain that excavation and compacted subgrades or subbases are adequate to receive the new Work. Correct defects and deficiencies before proceeding with the Work.

3.02 Subgrade Conditions

- A. Prior to the placing of any aggregate material, examine the subgrade or subbase to ascertain that it is adequate to receive the aggregate to be placed. If the subgrade or subbase remains wet after all surface water has been removed, ENGINEER may require the installation of edge drain.

3.03 Existing Base

- A. Prior to the placing of any aggregate material for surfacing, examine the existing base for grade and condition to receive the new Work. Ascertain that the base is adequately compacted to receive the aggregate surfacing to be installed. Correct defects and deficiencies before proceeding with the Work.

3.04 Existing Improvements

- A. Investigate and verify locations of existing improvements, including structures, to which the new Work will be in contact.
- B. Necessary adjustments in line and grade, to align the new Work with the existing improvements must be approved by ENGINEER, prior to any changes.

3.05 Preparation of Subgrade or Subbase

- A. Subgrade or subbase shall be fine graded to the cross section indicated on the Plans, and shall be thoroughly compacted prior to the placing of the aggregate material.

3.06 Installation - General

- A. Width, thickness, and type of aggregate materials shall be indicated on the Plans or as directed by ENGINEER.
- B. No aggregate material shall be placed until the subgrade, or subbase, or existing aggregate surface has been approved by ENGINEER.

3.07 Aggregate Surface Course

- A. Where the base for the new aggregate surface course is an existing aggregate surface, the existing surfacing, shall be either graded or scarified and graded to remove irregularities and to provide a bond between the old and new surfaces.
- B. Aggregate surface course shall be placed by a mechanical spreader or other approved means, in uniform layers to such a depth that when compacted, the course will have the thickness shown on the Plans.
- C. Depth of the surface course, when compacted, shall not exceed 6 inches (150 mm), unless otherwise specified on the Plans or directed by ENGINEER. Aggregate shall be of a uniform mixture when placed on the prepared base. It shall be uniformly spread and then trimmed with a road grader, trimmer or other approved means until the surface is free from waves and irregularities. Trimming shall be alternated by rolling with a pneumatic-tired or tamping type roller. The entire operation shall continue until the surface course is compacted to at least 95% of maximum unit weight.
- D. When the operation is completed, the surface course shall conform to the required lines, grades and cross sections.
- E. Optimum moisture content shall be maintained until the prescribed unit weight is obtained and each layer shall be compacted until the maximum unit weight is attained before placing the succeeding layer.
- F. When approved by ENGINEER, additional water may be applied by an approved means, to the aggregate to aid in the compaction and shaping of the material.
- G. With the approval of ENGINEER, chloride additives may be used by CONTRACTOR to facilitate his compaction and maintenance of the aggregate surface. Amount and method of combining the chloride additives are at the option of CONTRACTOR and are at his expense.

3.08 Aggregate Shoulders and Approaches

- A. Construction of shoulders and approaches shall be of the material, width and depth as shown on the Plans.
- B. When shoulders and approaches are specified by class, they shall conform to MDOT Section 307 for shoulders and approaches specified as: Class I, Class II, Class III or Class IV.

- C. The subgrade for the shoulders and approaches shall be graded to an elevation below the finished surface that will permit the placing of the specified thickness of materials.
- D. The subgrade of shoulders and approaches shall be approved by ENGINEER prior to the placing of aggregate.
- E. The aggregate shall be placed on the prepared subgrade by a mechanical spreader or other approved means, to a depth of not more than 5 inches (125 mm). If the specified thickness exceeds 5 inches (125 mm), the shoulder or approach shall be constructed in two or more courses.
- F. Dumping the aggregate on the road surface and grading it onto the shoulder or approach will not be permitted.
- G. The aggregate shall be compacted to not less than 100% of the maximum unit weight for the first 5 feet (1.5 m) outside of the pavement edge and 98% of the maximum unit weight for the remainder of the area. When the operation is completed, the surface course shall conform to the required lines, grades and cross sections.
- H. On resurfacing projects, the existing aggregate shoulder or approach shall be scarified prior to the placing of new aggregate materials. The placement of aggregate shall proceed the placing of the top course of bituminous mixture on the adjoining pavement. Final shaping and compaction of the shoulder or approach shall follow the placement of the top course of bituminous mixture unless otherwise directed by ENGINEER.
- I. The optimum moisture content shall be maintained until the prescribed unit weight is obtained and each layer shall be compacted until the maximum unit weight is attained before placing the succeeding layer.
- J. When approved by ENGINEER, additional water may be applied by an approved means, to the aggregate to aid in the compaction and shaping of the material.
- K. With the approval of ENGINEER, chloride additives may be used by CONTRACTOR to facilitate his compaction and maintenance of the aggregate surface. Amount and method of combining the chloride additives are at the option of CONTRACTOR and are at his expense.

3.09 Maintenance During Construction

- A. Aggregate surface shall be continuously maintained in a smooth and firm condition during all phases of the construction operation.
- B. CONTRACTOR, at his expense, shall provide additional materials needed to fill depressions or bind the aggregate.

3.10 Temperature Limitations

- A. Aggregate materials shall not be placed when there are indications that the mixtures may become frozen before the maximum unit weight is obtained.
- B. In no case shall the aggregate be placed on a frozen subgrade or base course unless otherwise directed by ENGINEER.

3.11 Cleanup

- A. Immediately following the compacting of the surface course, the voids on both sides of the aggregate course shall be backfilled with sound earth of topsoil quality.
- B. The backfill shall be compacted, leveled and left in a neat, workmanlike condition.
- C. At a seasonally correct time approved by ENGINEER, the disturbed area shall be raked, have topsoil placed thereon, fertilized and seeded per the requirements of Section 32 9219, Seeding or sodded in accordance with Section 32 9223, Sodding.

3.12 Opening Aggregate Surfaced Roads

- A. ENGINEER reserves the right to open the aggregate surfacing to traffic at any time during construction.

3.13 Monument Boxes

- A. All government, plat, and street intersection monuments within existing or proposed pavement shall be preserved by enclosing in standard monument boxes. Monument box castings shall be furnished and installed by CONTRACTOR and shall be East Jordan Iron Works No. 1570, or approved equal.
- B. Existing monument boxes shall be adjusted to meet the proposed pavement elevation by removing the castings and resetting to the required elevation. Support for the monument box shall be concrete bedding, so constructed as to hold them firmly in place. Adjacent pavement, curb, or curb and gutter shall be replaced to the new elevation, condition, and kind of construction, unless otherwise provided.

3.14 Testing

- A. During the course of the Work, the ENGINEER may require testing for compaction or density and for thickness of material. Testing and coring required shall be performed by a testing laboratory acceptable to OWNER and approved by ENGINEER. The cost for testing and coring shall be at the expense of OWNER.
- B. When thickness tests are done, a minimum of one depth (thickness) measurement will be made every 400 linear feet (120 m) per traffic lane. The lane width shall be as indicated on the Plans or as determined by ENGINEER. If 2 lanes are constructed simultaneously, only one test is necessary to represent both lanes. For areas such as intersections, entrances, cross-overs, ramps, widening strips, acceleration and deceleration lane, at least one depth measurement will be taken for each 1,200 square yards (1000 m²) of such areas or fraction thereof. The location of the depth measurement will be at the discretion of ENGINEER.
- C. The maximum unit weight when used as a measure of compaction or density of soils shall be understood to mean the maximum unit weight per cubic foot (or cubic meter) as determined by ASTM D1557, Method D.

3.15 Defective Work

- A. Thickness:

1. Measurements of aggregate base and/or surface course thickness will be made to the nearest 1/4 inch (5 mm). Depths may be 1/2 inch (10 mm) less than the thickness indicated on the Plans provided that the average of all measurements taken at regular intervals shall be equal to or greater than the specified thickness. In determining the average in place thickness, measurements which are more than 1/2 inch (10 mm) in excess of the thickness indicated on the Plans will be considered as the specified thickness plus 1/2 inch (10 mm).
2. Locations of the depth measurements will be as specified herein unless otherwise directed by ENGINEER. Sections found to be deficient in depth shall be corrected by CONTRACTOR using methods approved by ENGINEER.

B. Weight:

1. When the aggregate material is measured by weight in Tons (or metric tons), the pay weights for aggregates will be the scale weight of the material, including admixtures, unless the moisture content is more than 6 percent.
2. Moisture tests will be made at the start of weighing operations and at any time thereafter when construction operations, weather conditions or any other cause may result in a change in the moisture content of the material.
3. If the tests indicate a moisture content in excess of 6 percent, the excess over 6 percent will be deducted from the scale weight of the aggregate until such time as moisture tests indicate that the moisture content of the material is not more than 6 percent.

End of Section

Section 32 1713 Parking Bumpers

Part 1 General

1.01 Scope of Work

- A. This Section includes parking bumper fabrication, delivery, storage, installation and anchoring as well as protection and restoration of damaged Work.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200
- B. Section 32 1216
- C. Section 32 1313

1.03 Reference Standards

- A. ASTM - ASTM International
- B. MDOT - Michigan Department of Transportation, 2003 Standard Specifications for Construction

1.04 Submittals

- A. Submit manufacturer's literature showing material types and sizes, fabrication methods and finishes.

1.05 Product Storage and Handling

- A. Store parking bumper units in an area acceptable to ENGINEER. Unit shall be stored in a location and a manner that will afford protection from damage due to construction operations or vandalism.
- B. Parking bumpers shall be lifted using acceptable slings or other equipment which will not cause cracking, breaking or chipping of the units during handling. Bumpers shall not be dropped.

Part 2 Products

2.01 Concrete

- A. In accordance with MDOT Section 701, use Grade S2; 3,500 psi (24 MPa) strength; Type IA cement; 6.0 sacks cement per cubic yard (355 kg/m³); 6A coarse aggregate; 2NS fine aggregate; 6%±1% air content; 3-inch (75 mm) maximum slump; no admixtures without ENGINEER's approval.

2.02 Concrete Reinforcement

- A. In accordance with MDOT Section 905, use ASTM A615, Grade 60 for bars and ASTM A185 for welded wire fabric.

2.03 Anchor Pins

- A. Steel pins, as supplied by the manufacturer, shall be used to anchor parking bumpers. Pins shall have a minimum diameter of 9/16 inch (15 mm) and the length no less than the height of the bumper plus 12 inches (300 mm).

2.04 Fabrication and Manufacture

- A. Precast concrete parking bumpers shall be factory cast to the size and dimensions indicated on the Plans by the manufacturer's standard fabrication methods. Units shall be cast with reinforcing steel bars and shall have a minimum of two (2) cast-in or drilled anchor holes as indicated. Edges, corners, angles and returns shall be sharp and true without burrs or breaks and all plane surfaces shall be flat. Parking bumper units shall be steam or moist cured using manufacturer's standard methods to provide the compressive strength specified. Standard type units shall be provided with flat, solid bottoms. Drain type units shall have flat, solid bottoms with slotted drainage openings as indicated on the Plans. Concrete finish for concrete parking bumper units shall be rough sand type.

2.05 Acceptable Manufacturers

- A. Acceptable manufacturers include Nu-Cast Step and Supply Company, Redford, MI; American Vault and Concrete Products Corporation, Detroit, MI; Dura-Crete, Warren, MI; or equal.

Part 3 Execution

3.01 Installation

- A. Parking bumper units shall be placed, as nearly as possible, to the locations and lines indicated on the Plans. In unloading and placing units, suitable skids, slings, straps or other lifting devices which will not cause damage or breakage of the units shall be used. Parking bumpers shall not be dragged, bumped or dropped during installation. Installation shall be such as to protect the paving and the parking bumpers at all times.
- B. Parking bumpers shall be secured in place at the locations shown on the Plans and by methods recommended by the manufacturer. Where drilling of pavement is called for, drilling equipment shall be acceptable to ENGINEER.

End of Section

Section 32 1723 Pavement Markings

Part 1 General

1.01 Scope of Work

- A. This Section includes pavement markings complete with materials, layout of markings and preparation of pavement surfaces.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200: Unit Prices

1.03 Reference Standards

- A. Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. ASTM - American Society of Testing and Materials
 - 2. AASHTO - American Association of State Highways and Transportation Officials
 - 3. MDOT - Michigan Department of Transportation, Standard Specifications for Construction, latest edition

1.04 Requirements of Regulatory Agencies

- A. Where applicable pavement markings shall conform to the current requirements of the Michigan Manual of Uniform Traffic Control Devices (M.M.U.T.C.D.) issued under provisions of the Michigan Vehicle Code, Act 300, PA 1949, as amended.

1.05 Submittal of Manufacturer's Literature

- A. Submit manufacturer's literature of all paints to be used in the Work. Manufacturer's literature shall show paint: type, texture, color, temperature limitations, recommended use, spreading rate, drying time, and cleanup.

1.06 Product Delivery, Storage and Handling

- A. Deliver all materials to the Project site in original, unopened waterproof containers. Packaging containers shall bear manufacturing labels intact and legible. The label shall contain the following information: name and address of manufacturer, shipping point, trade mark or trade name, kind of paint, formula, amount in U.S. gallons, date of manufacture and lot number, type of paint and AASHTO Specification Number.
- B. Store all materials in waterproof containers, under protective covering, off the ground and away from extreme heat or cold until ready for use.
- C. Handling of materials shall be in accordance with the manufacturer's recommendations.

1.07 Environmental Requirements

- A. CONTRACTOR shall comply with the appropriate environmental limitations (air temperature, pavement temperature, and relative humidity) as outlined in the MDOT Section 811.03.

Part 2 Products

2.01 Regular Dry Traffic Marking Paint

- A. Regular drying pavement marking paint in white and yellow colors shall conform to AASHTO M248, Type N traffic paint and shall meet the current MDOT specified ingredients for regular drying traffic paint and shall be selected from MDOT's Qualified Products List.

2.02 Fast Dry Polyester Pavement Marking Paint

- A. Fast drying pavement marking paint in white and yellow colors shall conform to AASHTO M248, Type F traffic paint and shall meet the current MDOT specified ingredients for fast drying traffic paint and shall be selected from MDOT's Qualified Products List.

2.03 Waterborne Pavement Marking Paint

- A. Waterborne pavement marking material in white and yellow colors shall conform to the current MDOT Specifications for waterborne pavement markings and shall be selected from MDOT's Qualified Products List.

2.04 Thermoplastic Pavement Markings

- A. Hot applied thermoplastic pavement markings in white and yellow colors shall conform to AASHTO M249, white and yellow thermoplastic striping materials (solid form), shall meet the current MDOT Specifications for hot applied thermoplastic paving marking and shall be selected from MDOT's Qualified Products List.

2.05 Cold Plastic Pavement Markings

- A. Preformed cold plastic pavement markers in white and yellow colors shall conform to the current MDOT Specifications for cold applied plastic pavement markings and shall be selected from MDOT's Qualified Products List.

2.06 Polyurea Pavement Markings

- A. Two-component, polyurea pavement marking material in white and yellow colors shall conform to the current MDOT Specifications and shall be selected from MDOT's Qualified Products List.

2.07 Temporary Pavement Marking Tape

- A. Temporary Pavement Markings Type R and Type NR shall conform to MDOT Section 922.06.A and shall be selected from MDOT's Qualified Products list.

2.08 Glass Beads

- A. Glass beads for reflectorizing white and yellow paint markings of pavement by the drop-in method on fresh paint stripes shall conform to the current MDOT Section 920.02 for glass beads for use in pavement markings for the type of paint specified.

Part 3 Execution

3.01 Verification of Existing Conditions

- A. Prior to the placing of any pavement markings, examine the limits of the new Work and ascertain that the existing surfaces are adequate to receive the material to be installed.

3.02 Preparation of Surface

- A. Surfaces to be painted must be thoroughly dry and free from dirt, loose paint, oil, grease, wax and other contaminants.
- B. Costs incurred for removing and disposing of unsuitable materials in preparation of the surfaces to receive the new Work, shall be incidental to the price paid for the pavement markings.

3.03 Performance - General

- A. Pavement marking operation shall be limited to the type of Work and the limits as specified on the Plans. If additional area is required by CONTRACTOR for storage of equipment or supplies, CONTRACTOR shall furnish ENGINEER with written permission obtained from the property owner of the storage area, permitting the storage.
- B. Unless otherwise specified on the Plans or approved by ENGINEER, CONTRACTOR shall conduct his operations and use of his equipment in such a manner that traffic will be maintained throughout the Project.
- C. For Work within public rights-of-way and other areas as determined by ENGINEER, the provisions for maintaining traffic shall be as specified in the Michigan Manual of Uniform Traffic Control Devices, and MDOT specifications for traveling convoys. Costs incurred in maintaining traffic shall be at CONTRACTOR's expense.
- D. CONTRACTOR's equipment shall have sufficient paint capacity to enable sustained pavement marking operations and shall be equipped so as to assure uniform application of the paint and thermoplastic pavement markings.
 - 1. Equipment shall have mechanical bead dispensers or pressurized bead dispensers. In general, the equipment shall be that necessary to accomplish the marking operations in a safe, efficient, and workmanlike manner.
 - 2. For parking lots and other small areas, approved portable equipment and use of hand methods will be allowed.
- E. The color of the paint, and the width or type of markings shall be as specified on the Plans or as directed by ENGINEER.
- F. Markings shall be applied so that they adhere adequately to the surface.
- G. Markings shall be applied in accordance with the applicable requirements of MDOT Section 811 for permanent pavement markings or Section 812.03 for temporary pavement markings. Unless otherwise specified, removal of temporary pavement markings shall be incidental to the Project.

3.04 Layout for Markings

- A. Layout work necessary for the location and placing of markings, as specified on the Plans or as determined by ENGINEER, shall be the responsibility of CONTRACTOR and shall be at his expense.

3.05 Application of Waterborne Markings

- A. Waterborne paint shall be applied when the air temperature is 50 degrees Fahrenheit or higher and the pavement is dry.
- B. CONTRACTOR shall be responsible for making the decision to apply waterborne paint on any specific day when there is a high probability of rain in the forecast. If applied lines are washed away because of rain, CONTRACTOR shall be responsible for re-applying the lines at no additional expense to OWNER.
- C. Waterborne pavement marking materials may be placed immediately on new bituminous pavement. Waterborne pavement marking material shall not be placed before May 1, or after October 1.
- D. Waterborne paint shall be applied with an application thickness of 15-mil and 8-mil dry thickness. Glass beads shall be added at the rate of 32 pounds per mile per 4-inch line, during the application process.

3.06 Application of Pre-formed Hot-Applied Thermoplastic Markings

- A. Since subsurface moisture can be present in amounts sufficient to affect proper bonding of the hot-applied thermoplastic material, CONTRACTOR shall be responsible for insuring that the pavement is free of excess moisture that may effect proper bonding prior to beginning work.
- B. Testing for moisture shall be documented and provided to ENGINEER.
- C. Minimum ambient air temperature shall be 48 degrees Fahrenheit and rising at the start of marking operations. If work is started and the air temperature falls below 45 degrees Fahrenheit, and continual cooling is indicated, all work shall be stopped. The minimum pavement temperature is 50 degrees Fahrenheit.
- D. Thermoplastic material shall be heated and applied within the temperature range recommended by the manufacturer. Thermoplastic material shall not be placed before May 14, or after October 1.

3.07 Application of Polyurea Pavement Markings

- A. Polyurea pavement markings shall not be applied over existing non-polyurea pavement markings. Existing non-polyurea pavement marking shall be completely removed before applying polyurea pavement markings. Remove curing compounds from concrete pavement. Apply at 15 to 25-mil thickness. Pavement shall be clean and dry. Pavement temperature shall be 40 degrees Fahrenheit or higher unless otherwise approved by ENGINEER.

3.08 Tolerances

- A. New markings and/or retraced markings shall be placed, with reasonable tolerance, in their proper locations.

- B. Incorrect or misplaced markings shall be obliterated and remarked in accordance with ENGINEER's instructions. Costs incurred to obliterate and remark incorrect or misplaced markings will be at CONTRACTOR's expense.

3.09 Protection of Markings

- A. Protection of the wet paint and thermoplastic pavement markings shall be the responsibility of CONTRACTOR, and all costs incurred to provide the protection will be at his expense.

3.10 Weather and Time Limitations

- A. Markings shall not be placed when rain is threatening or when the surface to be painted is wet.
- B. Pavement marking shall be performed during the period May 1 to November 1, unless otherwise approved in writing by ENGINEER. No markings shall be applied when the air temperature is less than 50 degrees Fahrenheit (10 degrees Celsius), as determined by ENGINEER.

End of Section

Section 32 9219 Seeding

Part 1 General

1.01 Scope of Work

- A. This Section includes seeding complete with earth bed preparation, providing and placing topsoil, preparation and fertilizing topsoil, sowing of seed for lawns and other ground cover, protection of seeded areas, watering of seeded areas, mowing of seeded areas, protection and cleanup.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200
- B. Section 01 8900
- C. Section 31 2200
- D. Section 32 9223

1.03 Requirements of Regulatory Agencies

- A. Comply with the applicable requirements of the Michigan Department of Agriculture, Pesticide and Plant Pest Management Division, Michigan Seed Law, Act 329, PA of 1965, as amended.
- B. Comply with the applicable requirements of the Proceedings of the Association of Official Seed Analysts, Rules for Testing Seeds.
- C. Chemical fertilizer shall be supplied in suitable bags with the net weight of the contents and guaranteed analysis shown on the container. Bulk shipments shall be accompanied by an analysis and net weight certification of the shipment. Custom mixed fertilizers shall be accompanied by a certification of the weight of each commercial fertilizer used in the mixture and a guaranteed analysis of each shipment expressed in percentages of total Nitrogen (N), total available Phosphoric Acid (P₂O₅) and total available Potash (K₂O) included.

1.04 Source Quality Control

- A. A seed mixture proposed for use in the Work shall have been tested for purity and germination by the Seed Producer within nine (9) months of sowing.

1.05 Reference Standards

- A. ASTM - American Society for Testing and Materials
- B. MDOT - Michigan Department of Transportation, Standard Specifications for Construction, latest edition

1.06 Submittals

- A. Submit Seed Producers Certification that seed meets the requirements of these Specifications and conform to the State of Michigan Seed Act referenced above under Article 1.03 of this Section.

- B. Where required, submit test reports for all seed proposed for use in the Work to ENGINEER, showing results of purity and germination tests, compliance with regulatory agencies, dates and location of tests.

1.07 Product Delivery, Storage, and Handling

- A. Material shall be delivered to the Project site in their original, unopened containers. Containers shall be clearly marked showing, name of manufacturer, brand name, trade name or generic name of material, warranty of analysis, net weight of contents and date of packaging, where applicable.
- B. Seed shall be delivered to the site in durable bags, tagged or labeled to show date of tests, warranty of purity and germination analysis, name, lot number and net weight of contents.
- C. Commercial fertilizers shall be delivered to the site of the Work in the original unopened bags. Bags shall not exceed 100 pounds (45 kg) net weight each and shall be clearly marked with guaranteed analysis in a conspicuous location on each bag.
- D. Material shall be stored at the Project site, under shelter, off the ground and shall be protected from damage by moisture, temperature, exposure to elements, vandalism or other action which might otherwise impair their use.
- E. Materials proposed for use in the Work shall be handled in a manner that will protect the material and the personnel involved in the Work. Handle seed in a manner which will protect the mixture from contamination or deterioration.

1.08 Environmental Requirements

- A. Seeding is limited to the periods between April 20 and June 1, August 10 to October 1 and after November 20 for as long as weather permits preparation of the seed bed without irrigation and/or mulch. With the use of irrigation and/or mulch, seeding can be done from April 20 thru October 1 inclusively.
- B. Comply with the limitations placed on the use of certain soil protection materials because of prevailing temperatures as described in this Section.
- C. Comply with the limitation placed on seeding applications because of wind velocity as described-in this Section.

1.09 Protection

- A. Provide suitably approved warning signs and barricades for protection of seeded areas from pedestrian or vehicular traffic. Protect all newly seeded areas during the progress of the Work and until completion of the turf establishment period.
- B. Protect all adjacent construction from topsoil spills and perform such cleanup of affected surfaces before it becomes compacted by traffic.

1.10 Final Acceptance

- A. CONTRACTOR shall establish a dense cover of seeded grass on disturbed areas.
- B. These areas shall be maintained until final acceptance of the Work by ENGINEER.

- C. ENGINEER will inspect the turf to ensure that the grass seed is well established, weed free, in a growing and vigorous condition.
- D. Areas that do not meet the approval of ENGINEER shall be re-seeded at CONTRACTOR's expense.

Part 2 Products

2.01 Seed

- A. Seed and seeding mixtures shall be certified, mature, clean, dry, new crop seed products suitable for the specified applications and having the percentages of purity, germination and proportions, by weight, indicated in Table 1.

Table 1 - Seeding Mixtures						
	Seeds		Mixture Proportions (%)			
Kind	Purity	Germination	TDS	TUF	TGM	THM
Kentucky Blue Grass	98%	80%	5	10	10	30
Perennial Rye Grass	96%	85%	25	20	20	20
Hard Fescue	97%	85%	25	20	30	
Creeping Red Fescue	97%	85%	45	40	40	50
Fults Salt Grass	98%	85%*		10		

Table 2 – Soil Types and Location of Seeding			
Symbol for Turf Seed Mixture	Soil Type	General Location	Rate of Seeding lbs/ac (kg/ha)
TDS	Dry Sandy to Sand Loam	Rural or Urban	250 (280)
TUF	All Types	Freeway, Blvds, Streets	250 (280)
TGM	Medium to Heavy	All	250 (280)
THM	Loamy to Heavy	Home and Business Turf	250 (280)

- B. The specific mixture to be used shall be for the type of soil on the Project and the location of the seeding unless otherwise indicated on the Plans or as designated by ENGINEER.
- C. Hydroseeding shall consist of a blend of seed, fertilizer and hydromulch.

2.02 Mulching Material

- A. Straw:
 - 1. Small grain straw or grass or marsh hay acceptable to ENGINEER.
- B. Wood Excelsior:
 - 1. Green wood fibers, baled or blanket of type and manufacture acceptable to ENGINEER.
 - 2. Wood excelsior shall be made of green timber fiber baled so that the bales weigh 80 to 90 pounds at the time of manufacture.

3. Wood excelsior blankets shall be made of a uniform web of interlocking fibers with a backing of fabric netting on one (1) side only. The fabric net shall have a mesh size not exceeding 1-1/2" x 3" (40 mm x 75 mm) and shall be a woven of either cotton cord, twisted paper cord or a synthetic, biodegradable fiber. Blankets shall be produced in the form of a tightly compressed roll 36 inches \pm 1-inch (900mm \pm 25 mm) wide and approximately 120 feet (36 m) long. Blanket shall have a fiber net on the outside of the fiber mat. Blanket roll weight, when manufactured, shall average 85 pounds (38 kg) \pm 10%. Each roll shall have separator sheets of 40 pound Kraft paper placed at the beginning and at the end of each roll to facilitate unrolling and handling at the job site. The Kraft paper sheet at the end of each roll shall also form a wrapper for the roll.
- C. Netting:
1. Twisted Kraft paper or synthetic fiber, biodegradable woven mesh net material suitable for the application and acceptable to ENGINEER.
 2. The net shall consist of a biodegradable mesh with openings not to exceed 1-1/2" x 3" (40 x 75 mm)
 3. The net shall be furnished in widths of not less than 35 inches (900 mm).
- D. Proprietary Mulch Material:
1. Biodegradable natural and/or synthetic materials suitably fabricated and acceptable to ENGINEER.

2.03 Mulch Anchoring Material

- A. Emulsified Asphalt:
1. ASTM D977, Rapid Setting (R.S. 1 or 2), Medium Setting (M.S. 2 or 2h) or Slow Setting (S.S. 1).
- B. Mulch Anchoring Tool:
1. Suitable unit having a series of flat, notched discs for punching and anchoring mulch in soil, or a regular farm disc weighted and set nearly straight as a substitute.
- C. Latex Base Adhesive:
1. Latex base adhesive mixed with water at a ratio of 25 gallon of water to 1 gallon adhesive with 25 pounds of recycled newsprint as a tracer (14 L of adhesive with 0.35 kL of water with 28 kg of newsprint).
- D. Recycled Newsprint:
1. Mix 7 pounds of newsprint with 7 gallons of water (60 kg of newsprint with 1000 L of water).
- E. Guar Gum:
1. Mix 1 pound of dry adhesive with 26.5 gallons of water with 5 pounds of recycled newsprint as a tracer (55 kg adhesive / 12 200 L water / 280 kg newsprint).

2.04 Fertilizer

- A. Fertilizer shall be a standard commercial grade fertilizer, conforming to state regulations, of the type recommended for grasses. The fertilizer shall contain slow release nitrogen amounting to 75% of the nitrogen available. Fertilizer shall be uniform in composition, free flowing and suitable for application with method selected. Fertilizer for hydraulic seeding shall be soluble or ground to a fineness that will permit complete suspension of all insoluble particles in the slurry.

2.05 Agricultural Liming Materials

- A. Burnt lime (quick lime), hydrated lime, limestone (calcite and dolomite), marble shells and by-products shall conform to the requirements of ASTM C602.

2.06 Water

- A. Free of matter harmful to plant growth.

2.07 Staples

- A. Wire staples for holding mulching materials in place shall be not less than six (6) inches (150 mm) long No. 11 (U.S. Steel Gage) steel wire or longer.

2.08 Topsoil

- A. Topsoil shall be fertile, friable, sandy clay loam without admixture of subsoil. Topsoil is to be free of glass, stones greater than one (1) inch (25 mm) in any dimension, weeds, undesirable grasses and other extraneous materials. Topsoil shall have the following range of values:

1.	Soil pH.....	5.0 to 7.5
2.	Soluble Salts.....	500 ppm max
3.	Organic Content.....	5 to 30 %
4.	Silt Content.....	35% to 50%
5.	Clay Content.....	5% to 10%
6.	Deleterious Material*.....	5% max

*rock, gravel, stone, sticks, roots, sod, etc.

- B. Compost may be mixed with topsoil to obtain the desired content. Topsoil is to be final screened thru a 5/8-inch (15 mm) maximum mesh screen prior to delivery to the Project site. ENGINEER shall review source and final screen results prior to release of topsoil. CONTRACTOR shall submit a certified analysis of the topsoil from each source to ENGINEER. Topsoil shall be placed in 3-inch (75 mm) minimum thickness throughout, or as specified in the plans or Specifications.
- C. CONTRACTOR shall obtain his own topsoil borrow pit source and shall obtain all necessary permits and agreements for the use of such borrow pits at his own expense.

2.09 Improved Topsoil

- A. Improved topsoil shall consist of a mixture of 2/3 topsoil and 1/3 compost. Compost shall be mature/stabilized, humus-like material derived from the aerobic decomposition of yard waste (i.e., grass clippings and leaves) or other materials as designated compostable as defined in P.A. 641 as amended and shall be in compliance with all federal and state law.

- B. The improved topsoil mixture shall have a dark brown or black color, be capable of supporting plant growth without ongoing addition of fertilizers or other soil amendments and shall not have objectionable odor. The mixture shall be free of glass, plastic, metal, and other contaminants, as well as viable weed seeds and other plant parts capable of reproducing. The mixture shall be such that no visible water or dust is produced when handling it.
- C. The manufacturer of the compost shall maintain annually on file with the Michigan Department of Agriculture, Pesticide and Plant Pest Management Division, test data and a statement to show that the following criteria are being met by the compost provided for the project.
- D. The composition of the compost shall be within the following range of values:
- | | | |
|-----|-----------------------------|------------------------------|
| 1. | Quality Parameter..... | Range of Value |
| 2. | Soil pH..... | 6 to 7.5 |
| 3. | Soluble Salts..... | 2 to 5 mmho/cm |
| 4. | Carbon/Nitrogen Ratio..... | 13 to 20 parts C to 1 part N |
| 5. | Inerts..... | < 1% |
| 6. | Organic Matter..... | 35 to 55 % |
| 7. | Nitrogen..... | 1 to 2 % |
| 8. | Phosphorus..... | 0.2 to 0.8 % |
| 9. | Potassium..... | 0.5 to 1.5 % |
| 10. | Unit Weight..... | 535 to 775 Kg/m ³ |
| 11. | Moisture Content..... | 40 to 50 % |
| 12. | Particle Size..... | < 20 mm maximum |
| 13. | Water Holding Capacity..... | > 100% |
| 14. | Heavy Metals..... | None |
- E. Maturity/Stabilization: An acceptable test that can demonstrate Maturity/Stability.
- F. Temperature: The compost material must have undergone the procedure to significantly reduce the pathogen level as referenced in EPA 40 CFR, Part 257 Regulations, Federal Register Vol. 58, No. 32, dated 2/19/93; Rules and Regulations. The temperature must be maintained at 40° C for 5 days with a temperature exceeding 55° C for at least 4 hours.
- G. Pathogens and Trace Elements: Shall meet the requirements of EPA 40 CFR; Part 503 Regulations, Federal Register Vol. 58, No. 32, dated 2/19/93; Rules and Regulations.
- H. To comply with the annual filing requirements with the Michigan Department of Agriculture, Pesticide and Plant Management Division, the supplier of the compost shall certify that the compost meets Michigan P.A. 641 as amended and EPA 40 CFR, Part 257 and 503 Regulations, Federal Register Vol. 58, No. 32; dated 2/19/93; Rules and Regulations.
- I. A data sheet shall accompany the certification.
- J. The data sheet shall show the following:
1. Standard compost total nutrient test results, including N, P, K, Ca, Mg, Mn, Cu, Fe total carbon, pH, as provided by an acceptable testing laboratory
 2. Organic content
 3. Inert contamination
 4. Soluble salts

5. Carbon/Nitrogen ratio
 6. Proof of maturity/stability acceptable to the Michigan Department of Agriculture
- K. The certification and data sheets shall be mailed annually to the Michigan Department of Agriculture, Agriculture Environment Coordinator. The date shall be included on which the compost test results were mailed to the Michigan Department of Agriculture.

Part 3 Execution

3.01 Preparation of Subgrade

- A. Complete all fine grading within the areas to be covered with topsoil necessary to bring the surface of the proposed subgrade to the elevations indicated on the Plans and parallel to the proposed finished grade. The surface of the subgrade immediately prior to being covered with topsoil shall be raked or otherwise loosened to a minimum depth of two (2) inches (50 mm) to facilitate making a bond between the subsoil and the topsoil.

3.02 Preparation of Soil

- A. After the areas to be seeded have been brought to the required grade and properly trimmed and cleaned up, the existing soil shall be brought to a friable condition by harrowing or otherwise loosening and mixing to a depth of at least four (4) inches (100 mm). Lumps and clods shall be thoroughly broken. When the area to be seeded has been prepared and covered with a layer of topsoil as specified under Article 3.01 of this section, this operation will not be required.

3.03 Preparation of Mulch Material

- A. When seed is to be sown through mulch which has been in place for a period of more than two (2) weeks or which is being held in place by a surface-applied coating of asphalt emulsion or other adhesive, the mulched area shall be prepared for seeding by discing, a spike-toothed harrow, or by other means acceptable to ENGINEER.

3.04 Placing and Spreading Topsoil

- A. Topsoil shall be placed and spread over the area designated on the Plans, or as determined by ENGINEER, to a depth of four (4) inches, \pm 1-inch (100 mm \pm 25 mm) or to such depth as specified on the plans.
- B. In all cases, topsoil shall be placed to a depth sufficiently greater than that shown on the Plans or specified so that, after natural settlement or rolling, the completed Work will conform to the lines, grades and elevations shown on the Plans.
- C. Spreading of topsoil shall be completed in such a manner that seeding as specified can proceed without additional moving of topsoil. Topsoil furnished and placed shall be considered incidental to seeding unless otherwise specified in the Proposal.
- D. After topsoil is spread, all large earth lumps, rocks, roots, debris, or other foreign matter shall be raked and removed from the topsoiled area and legally disposed of by CONTRACTOR.

3.05 Fertilizing

- A. Chemical fertilizer shall be applied on the prepared soil surfaces at a minimum rate of 1/3 ton per acre (666 lbs/ac.) (750 kg/ha) of 12-12-12 fertilizer, or such other rate of another fertilizer mixture that yield 240 lbs/acre (270 kg/ha) of nutrient. Dry fertilizers shall be thoroughly disced, harrowed or raked into the soil to a minimum depth of not less than 1-inch (25 mm). Where hydraulic seeders are used for sowing seed, one half the recommended rate of fertilizer may be spread in combination with such sowing with the balance incorporated into the soil prior to seeding. In all other cases, fertilizer shall be incorporated into the soil before any seeding is started.

3.06 Seeding

- A. Seed of the kind required shall be sown at the rate as specified in Table 2. Seed shall be sown in the presence of an inspector by mechanical spreader, hydraulic seeder or broadcasting. The broadcasting method shall be used for sowing seed only in areas inaccessible to mechanical spreading equipment. Seeding during winds above 15 miles per hour (25 km/hr) shall not be permitted.
- B. Prior to placing seed materials, water topsoil to a depth of four (4) inches (100 mm) at least 48 hours prior to seeding operations to obtain a loose friable seed bed. Time and depth of watering operations shall be varied at the direction of ENGINEER for varying conditions at the site of the Work.
- C. Broadcasting methods for sowing seed materials shall be accomplished by spreading one-half of the specified amount of seed in one direction and then broadcasting the remaining one-half of the seed at right angles to the first seeding pattern using the same broadcast method. Rate of broadcast shall be as specified herein or per the written recommendations of the Producer of the seed material used. Roll seeded area with roller weighing a maximum of 150 pounds/foot (225 kg/m) of width.
- D. Hydroseeding shall be performed using suitably acceptable hydraulic seeding equipment and a homogeneous slurry solution of water, seed, fertilizer and suitable mulch material as approved by ENGINEER. Seed slurry mixture shall be distributed uniformly at a rate approved by ENGINEER for the seed materials, fertilizer and/or mulch materials used to suit the seed application rate. Seed application rate shall be 300 lbs/acre (340 kg/ha).

3.07 Mulching

- A. Mulching shall consist of placing a mulch material on areas that have been or are to be seeded. Mulch shall be placed in a loose enough condition so as to allow penetration of sunlight and circulation of air, but thick enough to shade the ground, reduce rate of water evaporation and prevent or reduce erosion by wind or water. Mulch shall be secured with suitably acceptable anchoring material.
- B. For surfaces and slopes on which power equipment can be operated, satisfactory mulching materials include the following:
- C. Small grain wheat straw or grass hay applied at 1-1/2 to two (2) tons per acre (3.5 to 4.5 metric ton/ha) with disc packer, asphalt or netting tie-down.
- D. Wood chips applied at six (6) to nine (9) tons per acre (13.5 to 20.0 metric tons/ha).

- E. Asphalt emulsion alone at 600 to 1,200 gallons per acre (5.5 to 11. kl/ha). (This application is suitable for limited periods of time and where trampling by either people or animals will not occur.)
- F. For surfaces and slopes where power equipment cannot be operated, satisfactory mulching materials include the following:
- G. Straw or grass hay applied at 1-1/2 to two (2) tons per acre (3.5 to 4.5 metric tons/ha), anchored with asphalt or netting tie-down.
- H. Asphalt emulsion alone at 600 to 1,200 gallons per acre (5.5 to 11.0 kl/ha). (Limited to areas where tracking is not a problem.)
- I. Commercially available erosion control netting of jute, paper or biodegradable synthetics.
- J. Continuous filament fiberglass at 1,000 pounds per acre (1100 kg/ha) anchored with 150 gallons (1400 l/ha) of asphalt emulsion.
- K. Anchor straw or hay mulch by the methods as specified herein.
- L. Wood chips will not need anchoring when used on workable slopes.
- M. Commercially manufactured netting and/or fiberglass materials shall be anchored in accordance with the manufacturer's printed instructions for the material used.
- N. Punch and anchor mulch material into soil using mulch anchoring tool. Soil must be moist, free of stones and loose enough to permit disc penetration to a depth of three (3) inches (75 mm).
- O. Blow on liquid or emulsified asphalt materials with the straw or hay mulch or spray or sprinkle asphalt tie-down materials immediately after mulch is spread.
- P. Apply emulsified asphalt at 0.04 gallons per square yard (0.2 l/m²). Do not apply emulsified asphalt during freezing weather since it contains approximately 50% water. Apply liquid (cut back) asphalt at approximately 0.10 gallons per square yard (0.45 l/m²). Liquid asphalt may be applied during freezing weather since it is cut back with kerosene.

3.08 Conversion from Soil Protection to Permanent Vegetation

- A. Following straw or hay mulching, grass seeding can be made in early spring by broadcasting seed directly into the mulch. Fertilizer or lime, where needed, should be incorporated into the soil before mulching.
- B. Asphalt emulsion alone can be readily incorporated into the soil by ordinary tillage before seeding.
- C. Wood chip mulch may be removed before seeding or incorporated deeply into the soil. If wood chips are incorporated into the soil, the addition of extra nitrogen fertilizer to the soil will be required to provide nitrogen in the new seeding.
- D. Fiberglass mulch shall be removed before seeding because of its permanence. Care shall be taken to prevent fiberglass filaments left in place from becoming entwined or wound around shafts of power mowers or other power equipment.

- E. Acceptable proprietary netting and erosion control materials shall be disposed of in accordance with the manufacturer's printed instructions for the material used prior to any seeding operations.

3.09 Turf Establishment

- A. Seeded areas shall be watered whenever excessive drying is evident during the period set for establishment. Watering shall be done in a manner that will prevent erosion due to the application of excessive quantities and the watering equipment shall be of a type that will prevent damage to the cultivated surfaces. CONTRACTOR shall be responsible for the proper care of the seeded areas until final acceptance of the entire Work covered by the Contract.
- B. The seeded areas shall be mowed with mowing equipment acceptable to ENGINEER to a height of two (2) inches (50 mm) whenever the average height of grass establishment reaches four (4) inches (100 mm). When the amount of cut grass is heavy, cut grass shall be removed to prevent destruction of the underlying grass. If weeds or other undesirable vegetation threaten to smother the planted species, such vegetation shall be mowed, or in the case of rank growths, shall be uprooted, raked and legally disposed of from the area.
- C. Reseed and mulch areas larger than four (4) square inches (25 cm²) not having a dense, uniform, vigorous stand of grass acceptable to ENGINEER.
- D. The establishment period shall extend for a period from the time of seeding until the seeded area has a uniform stand of grass acceptable to ENGINEER. The minimum period shall be 30 days.
- E. If after 60 days from the initial seeding a dense, uniform, vigorous stand of grass has not been established by CONTRACTOR, OWNER may reseed the defective areas and all costs will be deducted from CONTRACTOR's payments.

End of Section

Division 33
Utilities

Section 33 0130.16

Television Inspection of Sewer Utilities

Part 1 General

1.01 Scope of Work

- A. Section includes internal television (TV) inspection of sewer utilities using color closed-circuit television (CCTV) camera, and document inspection on video for the purpose of locating and observing the condition and possible extraneous connections.

1.02 Related Work Specified Elsewhere

- A. Section 33 0130.53: Cleaning of Sewer Utilities
- B. Section 33 0132: Geopolymer Lining System

1.03 Reference Standards

- A. Unless otherwise specified, the work for this Section shall conform to the applicable portions of the following standard specifications.
 - 1. NASSCO - National Association of Sewer Service Companies

1.04 Submittals

- A. Work Schedule:
 - 1. CONTRACTOR shall submit to OWNER prior to beginning television inspection a schedule for sequence of sewer utilities designated to be televised.
- B. Television Inspection Logs:
 - 1. Inspection reports shall be prepared by CONTRACTOR to go along with the video inspection and will clearly show the location in relation to the downstream utility structure of each point of significance observed during inspection.
 - 2. Points of significance will include wyes, roots, connections, broken or collapsed utilities, scale, corrosion, and any other unusual conditions or discernible features. Each will be recorded in a written report and an electronic copy of such report will be supplied to OWNER in accordance with the most current NASSCO Pipeline Assessment Certification Program (PACP) standards.
 - 3. The importance of accurate distance measurements is emphasized to enable location of the defects for rehabilitation work.
- C. Video Inspection Recordings:
 - 1. Purpose of video inspection recordings shall be to supply a visual and audio record of problem areas that may be replayed by ENGINEER/OWNER. Video recording shall be submitted in electronic format.
 - 2. Upon completion of the work, CONTRACTOR shall deliver a complete electronic copy of a written condition report and the video inspection recording to ENGINEER/OWNER in accordance with Section 01 3300, Submittal Procedures.

1.05 Job Conditions

A. Sewer Cleaning:

1. Prior to CCTV work, sewer utilities shall be cleaned so any cracks or other defects can be observed during the CCTV inspection work. The designated utilities shall be cleaned using hydraulically propelled, high-velocity jet, or mechanically powered equipment as specified in Section 33 0130.53, Cleaning of Sewer Utilities.

B. Sewer Flow Control:

1. When depth of flow at the upstream of the utility section being worked is above the maximum allowable for television inspection, flow shall be reduced to the level shown below by operation of pump stations, plugging or blocking of the flow, or by pumping and bypassing of the flow as specified in Section 01 5000, Temporary Facilities and Controls, and/or Section 33 130.81, Sewer Utility Flow Control.
2. Depth of flow shall not exceed that shown below for the respective utilities sizes as measured when performing television inspection.
 - a. Maximum Depth of Flow:

(1)	6" - 10"	20% of diameter
(2)	12" - 24"	25% of diameter
(3)	≥ 27"	30% of diameter
 - b. When the depth of flow in the utility is above the maximum allowable, or inspection of the complete periphery of the utility is necessary to effectively conduct the television inspection operations, one or more of the following methods of flow control shall be used. Where high flows are encountered after the utility has been cleaned, priority consideration shall be given to scheduling the CCTV inspection work for the late-night hours between 11:00 p.m. and 6:00 a.m.

C. Flood Prevention:

1. When flow in a sewer line is plugged, blocked, bypassed, or in any other way restricted, sufficient precautions must be taken to protect the sewer lines from damage that might result from sewer surcharging. Further, precautions must be taken to ensure that sewer flow control operations do not cause flooding or damage to public or private property being served by the sewers involved.

D. Working Hours:

1. CONTRACTOR must complete all work such that no homeowner is without sewer service, unless otherwise directed by OWNER. Local noise ordinances or agencies having control over roadway closures may control starting or stopping operations. Prior to starting operations, CONTRACTOR shall advise OWNER of the restrictions imposed by the local agencies.
2. CONTRACTOR may be required to work days, nights or weekends to achieve the lowest depth flows in the utility and not conflict with public events.
- 3.

No work will be allowed on weekends or holidays except at the discretion of OWNER.

1.06 Accessibility

- A. Due to site constraints in specific areas of the sewer system, it is highly recommended that prospective bidders review the project site locations for accessibility. Entry onto private property without permission is not authorized. Where permission is denied, it shall be CONTRACTOR's burden to develop an alternative approach to inspecting the utility.

1.07 Quality Assurance

- A. Experienced and pre-qualified personnel utilizing equipment and materials meeting the requirements of these specifications shall perform the Work specified herein.
 - 1. Prequalification shall require that the contracting company to perform the specified television inspection by a certified NASSCO trained operator having a minimum of three (3) years experience in the performance of the type of work specified and shall have specifically performed at least 100,000 feet of cleaning and television inspection within the past three years.
 - 2. A company with less than three (3) years experience may pre-qualify if they can demonstrate to the satisfaction of ENGINEER that they have the capabilities and overall experience, equipment and expertise to satisfactorily complete the project in accordance with these specifications.
- B. The CCTV software, database, and inspection reports shall be NASSCO certified (current version).

Part 2 Products

2.01 Television Camera and Equipment

- A. Television camera used for the inspection shall be one specifically designed and constructed for such inspection:
 - 1. Camera shall be "Pan and Tilt", color. Lighting for the camera shall be suitable to allow a clear picture of the entire periphery of the utility.
 - 2. Camera shall be operative in 100% humidity conditions.
 - 3. Camera, television monitor, and other components of the video system shall be capable of producing picture quality to the satisfaction of ENGINEER; and if unsatisfactory, equipment shall be removed and no payment will be made for an unsatisfactory inspection.
- B. Manual winches, power winches, television cable, and powered rewinds or other devices that do not obstruct the camera view or interfere with proper documentation of the sewer conditions shall be used to move the camera through the sewer line.
 - 1. When manually operated winches are used to pull the television camera through the line, telephones or other suitable means of communication shall be set up between the two manholes of the section being inspected to ensure good communications between members of the crew.

- C. The importance of accurate distance measurements is emphasized. Measurement for location of defects shall be above ground by means of a meter device. Marking on the cable, or the like, which would require interpolation for depth of manhole, will not be allowed. Accuracy of the distance meter shall be checked by use of a walking meter, roll-a-tape, or other suitable device, and the accuracy shall be satisfactory to ENGINEER.

Part 3 Execution

3.01 General

- A. CONTRACTOR shall locate all structures and note sewer diameter and direction of flow. Notify ENGINEER of detrimental access, structure, and/or sewer conditions which may adversely affect the progress of the Work. The inspection shall be done one manhole section at a time and the flow in the section being inspected shall be suitably controlled as specified herein. Closed-circuit television (CCTV) inspection shall be used to assess:
 - 1. Condition of existing utility.
 - 2. Root intrusion problems, if any.
 - 3. Internal defects that should be corrected and applicable repair or rehabilitation methods.
 - 4. Infiltration sources.
- B. CONTRACTOR shall coordinate on a daily basis and make provisions to ensure ENGINEER's representative is present whenever CCTV inspection work is being performed.
 - 1. While it is understood that ENGINEER's representative(s) may not always be present, CONTRACTOR understands that ENGINEER's representative(s) may be present at various points during the work to assess that quality requirements are carried on throughout the work.
- C. Inspections shall be performed while the line segments are in service without the need for plugging or flow diversion unless previously approved by ENGINEER. If necessary, CONTRACTOR shall schedule the work to be performed late at night between the hours of 11:00 PM and 6:00 AM. Late night CCTV inspection work shall not begin until CONTRACTOR has received approval from OWNER for a nighttime traffic control plan submitted by CONTRACTOR.

3.02 Maintenance of Traffic

- A. CONTRACTOR shall be responsible for maintaining traffic at all times and for notifying the proper authorities regarding the closing of roads. CONTRACTOR will be responsible for obtaining all permits required for maintenance of traffic.
- B. CONTRACTOR shall not begin work until standard barricades and warning signs are in an acceptable position and the markers and signs conform to the Michigan *Manual of Uniform Traffic Control Devices for Streets and Highways*, and all applicable state and local requirements. CONTRACTOR assumes all responsibilities and liabilities regarding strict adherence to applicable sections for the maintenance of traffic and public safety as set forth in the Michigan *Manual of Uniform Traffic Control Devices for Streets and Highways*, and other applicable regulations. Traffic control devices must be in place prior to starting work.

- C. CONTRACTOR shall maintain traffic at all times during all phases of this project in a manner causing the least amount of inconvenience to abutting property owners.
- D. Temporary driveways, temporary roadways, or run around as may be necessary to provide vehicular access to and from the abutting properties shall be constructed, maintained, and subsequently removed by CONTRACTOR as directed by OWNER and/or ENGINEER.
- E. The portion of the pavement not affected by the work shall be kept clear of all material and equipment. If at any time traffic has to be blocked (emergencies only), CONTRACTOR shall notify the nearest fire, police departments and service departments.
- F. Cost of maintenance of traffic shall be incidental to the Work and not measured for payment unless otherwise indicated.

3.03 Existing Utilities

- A. CONTRACTOR must take the necessary precautions for the protection of any utility encountered on the project or the restoration of any utility damaged during the work.
- B. If an excavation is required, CONTRACTOR shall notify, at least 48 hours before breaking ground, all public or private service corporations having wire, poles, pipes, conduit, manholes, or other structures that may be affected by this operation, including all structures which are affected and not shown on these plans. Owners of underground utilities, which are members of the state's one call service, can be notified by calling. Non-member underground utility owners must be called directly.
- C. Maintenance, repair, and replacement of existing utilities shall be in accordance with the rules and regulations of the various utility companies having jurisdiction.
- D. Existing storm sewers, drains, surface drainpipes and other property, removed or damaged during construction shall be repaired and reconnected by CONTRACTOR as directed by OWNER at no additional cost to OWNER.

3.04 Television Inspection and Computerized Equipment

- A. CONTRACTOR shall use a color pan and tilt camera or a side wall scanning (panoramic) camera specifically designed and constructed for sewer utility inspection. Each utility to be televised shall be suitably isolated to control flow during the inspection. CONTRACTOR shall provide a recording of the televised inspection, locating each connection entering the utility.
- B. Lighting for the pan and tilt camera or side wall scanning camera shall provide a clear picture of the entire periphery of the existing utility.
- C. The pan and tilt camera shall pause, pan, and visually inspect all connections, pipe ends, and maintenance or structural defects. If utilizing a camera with side wall scanning capabilities, pausing and panning of each lateral is not necessary during the inspection if the image clearly depicts the inside of the lateral for post processing. If a blockage cannot be removed and hampers the televising in one direction, then CONTRACTOR shall attempt to complete the section by televising from the other direction to complete the section, this reversal should immediately follow the initial direction. CONTRACTOR must immediately report the obstruction to OWNER.

- D. Side wall scanning inspection systems are imaging cameras that are capable of a continuous 360-degree image capture of the utility being inspected. These systems may have one or multiple cameras to capture the complete interior view of the utility.
- E. Once CONTRACTOR has completed the inspections, the captured images can be linked with a companion software package that allows for identifying and coding defects and features in the utility.
- F. If the image quality is not adequate for post-inspection coding, CONTRACTOR shall be required to repeat the survey at CONTRACTOR's expense.
- G. CONTRACTOR shall perform all CCTV inspections in accordance with NASSCO's Pipeline Assessment Certification Program (PACP). CCTV inspections will be delivered entirely in electronic format.
 - 1. Entire survey shall be recorded in an approved electronic format submitted with electronic links between the data and the video.
 - 2. Television inspection reports shall be within ± 2 feet of the measured linear footage between structures along the existing centerline of the utility from the start of the utility to the end of the utility.
 - 3. OWNER and PACP-required header information must be fully and accurately entered on all CCTV reports.
 - 4. Work not following these specifications may be rejected for payment and CONTRACTOR may be required to re-do the work.
- H. CONTRACTOR shall provide a PACP-certified operator onsite during the entirety of inspection activities.
 - 1. If video is to be coded separately from the actual recording, both the onsite operator and the individual performing the PACP coding shall be PACP certified.
 - 2. CONTRACTOR shall provide proof of certification prior to commencement of work, prior to a change in personnel involved in data collection, and as requested by OWNER.
- I. CCTV Reports, logs, electronic reports, and worksheets must include the following information and conform to the applicable guidelines:
 - 1. CCTV Reports, NASSCO PACP Certified Database, and electronic worksheets must accompany all inspection work.
 - 2. OWNER and NASSCO PACP required header information must be fully and accurately entered on all CCTV reports.

3.05 Unacceptable Conditions

- A. Camera lens shall be kept clean and clear and any fogging due to oil, grease, or other material or debris. Material that obscures the lens shall be cleaned off before proceeding with the recording operation. If debris or other obstructions cause reduced visibility, or if the image is obscured, CONTRACTOR shall make reasonable attempts to clear the lens of the camera before continuing inspection.
- B.

Camera lens shall remain above the visible water level and may submerge only while passing through clearly identifiable line sags. If at any time the flow exceeds 25 percent of the diameter of the utility, the inspection must be stopped until the flow subsides or, if necessary, CONTRACTOR shall reschedule the inspection, possibly for a late night inspection.

- C. Other unacceptable conditions that shall serve as a cause for rejection of submitted videos include, but are not necessarily limited to:
 - 1. Loss of vertical hold which impacts the ability to read and interpret the video.
 - 2. Incorrect manhole identifications if it is not clear which line has been televised.
 - 3. Inaccurate footage readings. The footage measurements shall form the basis for possible subsequent repair or rehabilitation work.
- D. Inaccuracy in the continuous footage measurement to a defect or any identifiable feature which leaves doubt as to the accuracy of the location of a specific defect or the total length of the utility segment shall render the video of the segment as unacceptable.
- E. Other unidentifiable defect such as equipment interference or malfunction, blurred or obscured images from an unknown source that detracts from the ability to read the video with reliable accuracy.

3.06 Property Damage

- A. CONTRACTOR shall immediately investigate any and all reports of flow backing up into fixtures served by the utility section that is being cleaned or televised.
- B. CONTRACTOR will be required to notify OWNER immediately if he causes any damage to private or public property caused by activities related to this Contract. CONTRACTOR shall make repairs and/or clean the property immediately in a timeframe that is acceptable to OWNER.

3.07 Cleanup

- A. CONTRACTOR shall keep the work area in an uncluttered condition by the frequent removal of debris. CONTRACTOR shall remove all debris and unused material and leave the area in a condition similar to the condition of the area before any work was performed.

End of Section

Section 33 0130.53

Cleaning of Sewer Utilities

Part 1 General

1.01 Scope of Work

- A. CONTRACTOR shall provide materials, labor, equipment, and services necessary for sewer line cleaning, manhole cleaning, and internal obstruction removal.
 - 1. Cleaning shall remove sediment, rocks, debris, roots, grease accumulations and obstructions from length of sewer and manholes to be lined, as well as hydraulic root cutting and/or grinding/cutting protruding break-in service connections
 - 2. Cleaning of sewer and manhole walls in vicinity of lining shall remove grease, scale, encrustation and loose mortar so that no foreign intrusion shall cause imperfections in lining (e.g. bumps, folds, dimples).
 - 3. Sewer cleaning methods shall be washing with high pressure water or other as approved by ENGINEER.

1.02 Related Work Specified Elsewhere

- A. Section 33 0130.16: Television Inspection of Sewer Utilities
- B. Section 33 0132: Geopolymer Lining System

1.03 Submittals

- A. Methods:
 - 1. CONTRACTOR shall submit a letter that identifies methods that will be used to remove sediment, debris, grease, scale, encrustations, loose concrete, roots and break-in connections throughout section of sewer to be cleaned. Include the following:
 - a. Detailed explanation of cleaning process.
 - b. Schedule of activities.
 - c. References where identified cleaning method(s) has been used successfully in the past by CONTRACTOR.
 - d. List of the actions to mitigate impact to OWNER during cleaning operation.
- B. Schedule:
 - 1. CONTRACTOR shall submit a schedule that outlines the sequence in which CONTRACTOR proposes to conduct his/her operations and shall be approved by ENGINEER/OWNER before work is started. Original and updated schedules must be provided to ENGINEER/OWNER electronically. The schedule shall:
 - a. use a time-scaled logic diagram format;
 - b. provide a level of detail of activities that are clear and concisely communicate of the plan of work; and

- c. at a minimum show initial mobilization, start-up, cleaning and televising, and any resultant point repairs shall be included.
2. Software used for producing the schedules must have the capability to tailor the form and format of schedules, and accompanying reports, to OWNER's requirements.
3. ENGINEER/OWNER may require additional updates to the schedule as changes occur. These additional updates will be submitted to ENGINEER within 24 hours of the request.
4. Changes to the schedule are subject to approval of ENGINEER/OWNER.

Part 2 Products

2.01 Materials

- A. Do not use chemicals without written approval of ENGINEER. Do not use chemical which may be considered hazardous or detrimental to organisms or equipment of wastewater treatment plant.

2.02 Equipment

- A. High-Velocity Hydraulic (Hydro-Cleaning) Equipment: Equipment shall be capable of removing dirt, grease rocks, sand, roots, and other materials and obstructions from sewer lines and manholes.
 1. Equipment shall have selection of two or more high-velocity nozzles. Nozzles shall be capable of producing scouring action from 15 to 45 degrees in all size lines designated to be cleaned, with nozzle capable of producing flows from fine spray to solid stream.
 2. Equipment shall carry its own water tank, auxiliary engines, and high-pressure water pump.
 3. Combination Unit Pump: Capable of pumping at least 80 gallons per minute (300 liters per minute) at 2,000 psi (13.8 MPa), measured at beginning of hose reel.
 4. Water Pump: Able to run at 2,000 psi (13.8 MPa) while pulling full vacuum, completely independent from vacuum system, with ability to vary vacuum without affecting water pressure.

2.03 Water

- A. When water is necessary, apply to OWNER for permission to use potable water source. When CONTRACTOR has been authorized to take water from OWNER-supplied water source:
 1. Water shall be conserved and not used unnecessarily.
 2. Only approved fire hydrant wrenches and shut off valves shall be used.
 3. A visible air gap shall be maintained between the discharge of the fire hose and CONTRACTOR's water storage tank. The air gap shall be visible from the ground surface.
 4. No fire hydrant shall be obstructed except to refill empty water tanks.

- B. CONTRACTOR shall provide temporary piping, valves, certified reduced pressure backflow preventors, equipment, and other items for handling potable water and wastewater.
- C. Do not utilize water source until it has been approved for use by OWNER.

Part 3 Execution

3.01 General

- A. CONTRACTOR shall clean the sewer and associated manholes, including drop connections and benches, to remove all Deposits Settled (DS), so that the sewer is ready for televising. This will require an unlimited amount of passes of a hydraulic flusher to remove all loose debris and collect it for removal in the downstream manhole. All debris must be removed from the sewer, including any debris that may have been washed up into any service connections (does not include known pre-existing conditions in service connections), drop connections or the bench wall of the manholes. This item does not include any root cutting, deposit removal, or grinding of protruding service connections.
- B. Cleaning shall be performed while the line segments are in service without the need for plugging or flow diversion unless previously approved by ENGINEER. If necessary, CONTRACTOR shall schedule the work to be performed late at night between the hours of 11:00 PM and 6:00 AM. Late night cleaning work shall not begin until CONTRACTOR has received approval from OWNER for a nighttime traffic control plan submitted by CONTRACTOR.

3.02 Maintenance of Traffic

- A. CONTRACTOR shall be responsible for maintaining "local" traffic at all times and for notifying the proper authorities regarding the closing of the roads. CONTRACTOR will be responsible for obtaining all permits required for maintenance of traffic.
- B. CONTRACTOR shall not begin work until standard barricades and warning signs are in an acceptable position and the markers and signs conform to the traffic control plans detailed in the Contract Drawings and the latest edition of the *Michigan Manual of Uniform Traffic Control Devices*, and all applicable state and local requirements of the agency having authority over the roadways, or as directed by ENGINEER. CONTRACTOR assumes all responsibilities and liabilities regarding strict adherence to applicable sections for the maintenance of traffic and public safety as set forth in the *Michigan Manual of Uniform Traffic Control Devices*, and other applicable regulations. Traffic control devices must be in place prior to starting work.
- C. CONTRACTOR shall maintain local traffic at all times during all phases of this project in a manner causing the least amount of inconvenience to the abutting property owners. Temporary driveways, temporary roadways, or run around as may be necessary to provide vehicular access to and from the abutting properties shall be constructed, maintained, and subsequently removed by CONTRACTOR as directed by OWNER and/or ENGINEER.
- D. The portion of the pavement not affected by the work shall be kept clear of all material and equipment. If at any time traffic has to be blocked (emergencies only), CONTRACTOR shall notify the nearest fire, police departments and service departments.
- E. The cost of maintenance of traffic shall be incidental to the contract and not measured for payment unless otherwise indicated.

3.04 Existing Utilities

- A. CONTRACTOR must take the necessary precautions for the protection of any utility encountered on the project or the restoration of any utility damaged during the work.
- B. If an excavation is required, CONTRACTOR shall notify, at least 48 hours before breaking ground, all public or private service corporations having wire, poles, pipes, conduit, manholes, or other structures that may be affected by this operation, including all structures which are affected and not shown on these plans. Owners of underground utilities, which are members of the state's one call service, can be notified by calling. Non-member underground utility owners must be called directly.
- C. All maintenance, repair, and replacement of existing utilities shall be in accordance with the rules and regulations of the various utility companies having jurisdiction.
- D. All existing storm sewers, driveway drains, surface drainpipes and other property, removed or damaged during construction shall be repaired and reconnected by CONTRACTOR as directed by OWNER at no additional cost to OWNER.

3.05 Maintaining Flow

- A. It will be the responsibility of CONTRACTOR, throughout the tenure of this Contract, to provide and maintain sufficient flow at all times to pass any flash of flow and prevent any backwater flooding due to obstruction caused by cleaning equipment.
- B. CONTRACTOR shall be aware of flow conditions and be able to identify potential access problems to sewer access points.

3.06 Sewer Cleaning

- A. CONTRACTOR shall provide equipment that is specifically designed and constructed for sewer cleaning. Solids and debris resulting from the cleaning operation shall be collected and removed from the downstream manhole and disposed of at a site selected by OWNER and approved by appropriate jurisdictional personnel. Under no circumstances shall sewage solids be dumped onto the surface, street, or into ditches, inlets, or storm drains.
- B. CONTRACTOR shall use the manufacturer's recommended size tools for the various size pipes. Equipment recommended by the manufacturer to protect the manhole and pipe, such as pull-in slant jack rollers and roller and yoke assembly, roller manhole jacks, etc. shall be utilized.
- C. CONTRACTOR shall clean designated sewer lines using approved methods and equipment.
 - 1. CONTRACTOR shall have a CCTV camera in the sewer during all cleaning operations to verify that the cleaning equipment is not damaging the public sewer. The use of CCTV equipment shall be in accordance with Section 33 0130.16, Television Inspection of Sewer Utilities.
 - 2. Remove internal obstructions such as roots or gaskets by trenchless techniques when obstruction encountered prevents further pipe cleaning.
 - a. Provide special attention during cleaning operation to assure almost complete removal of roots from joints.

- c. Procedures to remove internal obstructions may include use of equipment such as rodding machines, root saws, bucket machines and winches using root cutters, porcupines, and jet machines equipped with hydraulically driven cutters.
- 3. If cleaning of entire section cannot be successfully performed from one manhole, set up equipment at other manhole and attempt cleaning again.
 - a. If successful cleaning cannot be performed or equipment fails to traverse entire sewer line section, it will be assumed that major blockage exists.
 - b. Temporarily suspend cleaning effort and immediately notify OWNER and ENGINEER.
 - c. Upon removal of obstruction, complete cleaning operation.
- 4. Employ satisfactory precautions to protect sewer line from damage that might be inflicted by improper use of cleaning equipment.
 - a. Immediately notify OWNER and ENGINEER if fresh soil, pieces of pipe, or other visible signs of potential problems occur during cleaning operation.
 - b. Ensure that water pressure created does not cause damage due to flooding of property being served by sewer section(s) involved.
- D. CONTRACTOR is required to submit documentation of the work that is performed and the type of debris removed, as well as landfill permits and disposal documentation.

3.07 Manhole Cleaning

- A. Include entire manhole interior, including manhole benches and walls. Incorporate into line cleaning operation by scouring walls with high velocity nozzle after pipe segment cleaning operation is complete.

3.08 Removal of Debris

- A. Sludge, dirt, rocks, sand, grease and other solids or semisolid materials resulting from cleaning operations shall be trapped and removed at the downstream manhole of the section being cleaned.
- B. Passing materials from manhole section to manhole section, which could cause line stoppage, accumulations of sand in wet wells or damage to pumping equipment, shall not be permitted.
- C. Solids or semi-solid material removed from the wastewater collection system during the cleaning operation shall be removed from the site and disposed of in a lawful manner. Do not discharge sewage or solids removed from downstream manholes, onto streets, or into ditches, catch basins or storm drains.

3.09 Property Damage

- A. CONTRACTOR shall immediately investigate any and all reports of sewage backing up into fixtures served by the sewer section that is being cleaned or televised.

- C. CONTRACTOR will be required to notify OWNER immediately if he causes any damage to private or public property caused by activities related to this contract. CONTRACTOR shall make repairs and/or clean the property immediately in a timeframe that is acceptable to OWNER.

3.10 Cleanup

- A. CONTRACTOR shall keep the work area in an uncluttered condition by the frequent removal of debris. CONTRACTOR shall remove all debris and unused material and leave the area in a condition similar to the condition of the area before any work was performed.

End of Section

Section 33 01 32

Geopolymer Lining System

Part 1 General

1.01 Scope

- A. This work consists of designing, furnishing and installing a geopolymer lining system for the rehabilitation of existing sewers, manholes and other designated structures using an approved geopolymer lining system that may be applied via spin cast or hand spraying.
- B. It is the intent of this specification to provide minimum standards for materials and methods for waterproofing, sealing, structural reinforcement and corrosion protection of the existing sewer, manhole and other designated structure. This specification therefore covers the general requirements for the referenced specifications, lining Manufacturer and Installer qualifications, submittal and guaranty guidelines, materials, pre-installation and installation procedures, and testing.
- C. CONTRACTOR shall provide labor, material, equipment and incidentals, such as dewatering, cleanout, pre- and post-CCTV inspection, pre-lining repairs, curing, etc., required to install the geopolymer lining system and appurtenances specified.
- D. CONTRACTOR shall design and install the lining such that the finished installation will be continuous, provide structural support, and be permanently adhered to the existing sewer, manhole and other designated structure. The design and installation procedure of the lining shall be performed by the Manufacturer of the lining system and/or its authorized sub-contractor (Installer) experienced in performing this work.
- E. Conform to OSHA requirements.

1.02 Related Work Specified Elsewhere

- A. Section 01 1100: Summary of Work
- B. Section 01 2200: Unit Prices
- C. Section 01 3300: Submittal Procedure
- D. Section 01 5000: Temporary Facilities and Controls
- E. Section 03 3103: Concrete Repair and Rehabilitation
- F. Section 33 0130.13: Cleaning of Sewer Utilities
- G. Section 33 0130.16: Television Inspection of Sewer Utilities

1.03 Reference Standards

- A. Reference standards listed herein are made a part of these specifications by reference to the extent stated herein and shall be the latest edition thereof. Where there are differences between codes, standards and these specifications, these specifications shall govern.
- B. Unless otherwise specified, the Work for this section shall conform to the applicable portions of the following standard specifications from the American Society of Testing and Materials (ASTM):
 - 1. ACI 305R Hot Weather Concreting
 - 2. ACI 306R Cold Weather Concreting
 - 3. ASTM C-33 Standard Specification for Concrete Aggregates.

4. ASTM C-39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
5. ASTM C-78 Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
6. ASTM C-109 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
7. ASTM C-172 Standard Practice for Sampling Freshly Mixed Concrete
8. ASTM C-267 Standard Test methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacing and Polymer Concretes
9. ASTM C-157 Modified Standard Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete
10. ASTM C-293 Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading)
11. ASTM C-309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
12. ASTM C-403 Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
13. ASTM C-469 Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
14. ASTM C-496 Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
15. ASTM C-666 Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
16. ASTM C-801 Standard Test Method for Time of Setting of Hydraulic Cement Mortar by Modified Vicat Needle
17. ASTM C-882 Standard Test Method for Bond Strength of Epoxy Systems Used with Concrete by Slant Shear
18. ASTM C-1090 Standard Test Method for measuring Changes in Height of Cylindrical Specimens of Hydraulic-Cement Grout
19. ASTM C-1138 Standard Test Method for Abrasion Resistance of Concrete (Underwater Method)
20. ASTM C-1202 (AASHTO T 277 Equivalent) Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
21. ASTM C-666 Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
22. ASTM F-2414 Standard Practice for Sealing Sewer Manholes Using Chemical Grouting
23. ASTM F-2551 Standard Practice for Installing a Protective Cementitious Lining System in Sanitary Sewer Manholes
24. NASSCO Pipeline Assessment & Certification Program (PACP)

1.04 Submittals

- A. Product Data:
 - 1. Submit Manufacturer's technical literature, product data and installation instructions in accordance with Section 01 3300 at least 15 days prior to the start of rehabilitation work. Include, at a minimum, required substrate preparation, on-site quality assurance recommendations, curing requirements, physical properties, chemical resistance, Manufacturer's recommended mix, additives, set time, recommended handling and storage requirements, testing procedures, recommended equipment and list all materials and methods to be used.
- B. Certifications:
 - 1. Submit a letter of certification that the product meets or exceeds all technical requirements specified herein.
- C. Submit test results to indicate the materials meet physical properties specified herein.
 - 1. Submit third party verification of geopolymer material formulation via XRF (X-ray Fluorescence) data as specified herein.
 - 2. Submit Manufacturer's certifications that materials have been approved for the installation conditions shown on the Drawings and as specified herein.
- D. Submit Manufacturer's Materials Warranty certificate.
- E. Submit Installer's warranty certificate.
- F. Submit Installer's job history and reference certificates. CONTRACTOR shall submit with the bid documentation demonstrating CONTRACTOR's compliance with the qualification and experience requirements listed in Article 1.04.G of this Section, including a copy of the Manufacturer's licensee certificate.
- G. Qualification documentation as listed in Article 1.05 of this Section.
- H. Design:
 - 1. Submit lining thickness calculations, prepared by a Licensed Professional Engineer registered in the State, for review no later than the Pre-Construction Meeting.
 - 2. Lining thickness calculations shall be based on the following minimum design criteria:
 - a. Design lining with structural requirements based on a 50-year minimum design life.
 - b. Existing pipe condition is moderately to severely deteriorated rectangular segmented brick or concrete sewer.
 - c. Utilize AASHTO LRFD Bridge Design Specifications methodology with HL-93 loading.
 - d. Maximum long-term deflection of 5%.

1.05 Quality Assurance

A. Installer:

1. Submit documentation and verifiable references that the Installer has successfully installed the proposed geopolymer lining system in a minimum of 1,000 linear feet of large diameter (>36 inch) horizontal pipe and manholes in the United States and Canada and has been continually engaged in this type of work for a minimum of five (5) years.
2. Information submitted shall include pipe dimensions, length of installation, size/type of flow control required to perform the Work, description of the actual work performed including installation method, name and telephone number of the pipe owner and date of installation.
3. Stated experience requirements for licensed CONTRACTOR or Installer have to be projects which used approved lining Manufacturers. Reference experience shall be for the projects completed within the United States and Canada and shall have used the same installation method, and geopolymer lining system proposed for the project. Required experience shall include the following:
 - a. CONTRACTOR performing the lining of the sewer shall be licensed by the approved geopolymer lining Manufacturers. Submit a certified statement from the Manufacturer that the Installer is a certified and/or licensed Installer of the lining.
 - b. Licensed CONTRACTOR, or Installer, shall have experience in geopolymer lining of sewers including sewers, manholes and other structures similar in size to those shown in the Contract Drawings.
4. CONTRACTOR shall submit a work plan showing how the work shall be scheduled and coordinated.

B. Manufacturer:

1. Submit documentation and verifiable references that the proposed geopolymer lining system by the Manufacturer has been successfully installed in a minimum of 10,000 linear feet of large diameter (>36 inch) horizontal pipe and manholes in the United States and Canada and that the proposed geopolymer lining system had been in place for a minimum of five (5) years.
2. CONTRACTOR shall submit the Manufacturer's qualification information with his/her Bid. CONTRACTOR's Bid may be deemed non-responsive if said qualification information is not submitted.

C. Superintendent:

1. CONTRACTOR shall submit the Superintendent's qualification information with his/her Bid. CONTRACTOR's Bid may be deemed non-responsive if said qualification information is not submitted.
2. Information shall include the Superintendent's resume of projects. Each reference project shall include dimensions of installation, size/type of flow control required to perform the Work, description of the actual work performed including installation method, owner name, telephone number and contact person, and date of installation. CONTRACTOR shall submit the name(s) and qualifications for each scheduled Superintendent for the project.

- a. It is required that the Superintendents named are the Superintendents assigned to the project and onsite during construction.
 - b. Referenced experience shall be for projects completed within the United States or Canada and shall have used the same installation method, and geopolymer lining proposed for this project. References will be checked.
- 3. CONTRACTOR is required to have at least one (1) qualified Superintendent onsite at all times during installation activities.
- 4. Proposed Superintendent must have a minimum of three (3) years of geopolymer lining supervisory field experience using the methods and materials proposed for this work, as documented by verifiable references.
- D. Installation Crew:
 - 1. At least one (1) person other than the Superintendent from the installation crew shall have a minimum of one (1) year of experience. Crew member with listed qualifications must be onsite during all installation activities.
- E. The final decision to accept or reject the product, Manufacturer, and/or Installer, based on the submitted qualifications, lies solely with OWNER. The named Manufacturer, Superintendent, and Installation Crew must be employed to perform the Work, unless changes are specifically authorized by OWNER.

1.06 Warranty

- A. Materials specified herein shall be certified by the Manufacturer for the specified purpose. Manufacturer shall warrant the raw materials to be free from defects for a minimum of one (1) year from the date of installation and acceptance by OWNER. If Manufacturer's standard warranty length exceeds one (1) year, CONTRACTOR shall provide OWNER with Manufacturer's standard warranty.
- B. CONTRACTOR shall warrant the Work for a period of one (1) year. During the warranty period any defect, which may materially affect the integrity, strength, function and/or operation of the pipe, manhole or structure, shall be repaired at CONTRACTOR's expense.
- C. Manufacturer's warranty period shall run concurrently with CONTRACTOR's warranty period. No exception to this provision shall be allowed.

1.07 Shipping, Delivery and Storage

- A. Materials shall be shipped, stored, and handled in a manner consistent with written recommendations of the product Manufacturer to avoid damage.
- B. Onsite storage locations shall be approved by OWNER prior to delivery. Damaged materials shall be promptly removed from the site at CONTRACTOR's expense and disposed of in accordance with all current applicable agency regulations.
- C. Packages showing indications of damage that may affect condition of contents are not acceptable.

Part 2 Products

2.01 Acceptable Products

- A. Geopolymer lining system shall be "GeoSpray" as manufactured by Milliken Infrastructure Solutions, or ENGINEER approved equal.
- B. If CONTRACTOR will be proposing a product other than what is specified herein as an approved equal, the proposed substitution must be submitted at least ten (10) days prior to the scheduled Bid opening. If CONTRACTOR fails to submit the required information prior to the Bid opening, CONTRACTOR's Bid may be deemed non-responsive

2.02 Geopolymer Lining System

- A. Geopolymer lining system shall conform to the following properties:

Property	Testing Method	Requirements	
		1 Day	28 Days
Compressive Strength	ASTM C109	2,500 psi	8,000 psi
Flexural Strength	ASTM C78	1,100 psi	1,500 psi
Tensile Strength	ASTM C496	---	800 psi
Shrinkage	ASTM C1090	---	0% at 65% RH
Modulus of Elasticity	ASTM C469	3,000,000 psi	5,800,000 psi
Bond Strength	ASTM C882, Type II	900 psi	2,500 psi
Rapid Chloride Ion Permeability	ASTM C1202	---	Very Low (below 1000 Coulombs)
Freeze Thaw Durability	ASTM C882, Type II	zero loss at 300 cycles	
Set Time	ASTM C807	Initial Set: < 75 min Final Set: < 120 min	
Abrasion Resistance	ASTM C1138	5 Cyl.28 Day: < 3% loss	

2.03 Acid Mitigation System

- A. Liquid sealant must be applied to the geopolymer lining system after the final thickness has been cast. Sealant shall be designed to provide additional chemical protection for the geopolymer lining system from Microbial Induced Corrosion (MIC) and should be designed function with the geopolymer lining system.
- B. Liquid sealant shall be manufactured by the same Manufacturer as the geopolymer lining system.

2.04 Additional materials

- A. Additional materials including chemical grouts and hydraulic cements necessary to stop infiltration and create a surface for the geopolymer lining system to be applied to are specified on the Contract Drawings and Section 03 3103, Concrete Repair and Rehabilitation.
- B. Specific materials must be compatible with the geopolymer lining system and the OWNER reserves the right to require preapproval of such materials.

Part 3 Execution

3.01 Design of Geopolymer Thickness

- A. CONTRACTOR shall submit lining thickness calculations in accordance to Article 1.04.H of this Section.
 - 1. Minimum lining thickness, independent of design, shall be 1.5 inches for all conduits (pipes).
 - 2. Minimum lining thickness, independent of design, shall be 0.5 inches for all manholes or structures.
- B. Design of the geopolymer lining system should be based on physical properties of materials and should use the more conservative ASTM C78 values for Flexural Strength not values obtained from ASTM C293.
- C. Deterioration of pipes, manholes and structures such as those called out in this Work is an on-going process. Should pre-construction inspections reveal that the pipe, manhole or structure to be in a substantially different condition than those represented in the Contract Documents, CONTRACTOR shall request such changes in the reconstruction lining thickness, supporting such request with additional third-party certified design by registered Professional Engineer. The deviation, if approved, shall be reflected by the appropriate addition or reduction in the unit cost as agreed to by OWNER.

3.02 Execution

- A. General:
 - 1. Structural rehabilitation of the existing pipes, manholes or other designated structures will follow the procedures listed below.
 - 2. CONTRACTOR shall carry out their operations in strict accordance with all applicable OSHA standards.
 - 3. Local water will not be provided.
 - 4. Surfaces, which have been damaged by CONTRACTOR's operations shall be restored to a condition at least equal to that in which they were found immediately prior to the beginning of CONTRACTOR's operations. Suitable materials and methods shall be used for such restoration and OWNER reserves the right to approve both the methods and materials. Restoration of existing property or structures shall be done as promptly as practical and shall not be left until the end of the construction period. Damages by CONTRACTOR shall be restored at no additional cost to OWNER.
 - 5. CONTRACTOR shall treat all waste matter and materials removed from pipes, manholes or other designated structures as a contaminated material, unless otherwise specified, and shall ensure that the material is properly disposed of in accordance with the requirements of agencies having jurisdiction and/or local ordinances.

3.03 Preparation

- A. Install temporary Soil Erosion and Sedimentation Control (SESC) measures as shown on the Contract Drawings, including sediment trap/basin, filter berms, and check dams.

- B. Remove all debris from pipes, manholes or other designated structures. Clean the interior surface with a high pressure (3,000 psi minimum) water blast to remove all loose material, sediment, and scale. Flush sediment and remaining debris from the pipe. Collect sediment in a downstream trap or basin. Maintain sediment trap/basin, as directed, to prevent sediment from migrating downstream. Pump the impoundment into filter bags, if necessary, to prevent overtopping of the final downstream check dam. Properly dispose of all debris resulting from the cleaning operations.
- C. Inspect the surface to ensure it is free from sediment and other laitance that may impede placement of the lining system. Clear the pipes, manholes or other designated structures of obstructions such as solids, dropped joints, roots, protruding laterals, collapsed pipes, and other materials which may prevent proper installation of the lining system. Cut back drop inlets and taps flush with the surface to be repaired.
 - 1. Propose corrective action(s) to eliminate any obstruction(s) that cannot be removed by conventional methods and which will prevent the lining system from being installed properly to ENGINEER/OWNER. Obtain OWNER's approval for any proposed corrective action prior to commencing the Work.
- D. Carefully measure and document locations of drop inlets, taps and other openings to re-establish access through the lining system after installation. Conduct video inspection in accordance to Section 33 0134, furnishing a USB drive containing the results of the inspection to OWNER upon completion of said inspection.
- E. Prior to lining, temporarily plug drop inlets, taps and other openings to prevent water discharge onto newly placed lining material and to prevent lining material from entering the drop inlet, tap or other opening. Plug lines with active flow with a temporary bulkhead device that sufficiently prevents water from discharging onto the newly placed lining. Bulkhead any abandoned inlets, taps or other openings flush with the existing surface and install any new inlets, taps and other openings prior to installation of lining material.
- F. Seal off water seepage with hydraulic cement mortar or grout, expansive polymer foam, or other method approved by OWNER.
- G. Repair perforations in the existing surface by filling void space with hydraulic cement (repair) mortar.
- H. Pools of water shall be removed; however, a dry surface is not required.
- I. Patch holes and fill voids in and around existing pipe as directed by OWNER.

3.04 By-Pass Pumping

- A. Furnish, install and maintain necessary equipment and materials required to dewater the site and/or maintain flow around the area designated for lining.
- B. A bypass pumping system, if necessary, must provide adequate capacity to handle the existing flow plus any additional flow that may occur during periods of rainfall.
- C. Continuously monitor all pumps and equipment.
- D. Follow local noise ordinances if pumping is required on a 24-hour basis.
- E. By-passing pumping shall be in accordance with Article 1.19 of Section 01 5000, Temporary Facilities and Controls.

3.05 Lining Installation

- A. Geopolymer lining system shall be applied between in accordance with the Manufacturer's recommended temperature range. If multiple lifts of material are required to be placed, each lift shall be placed monolithically according to the Manufacturer's recommendations.
- B. Reinforcing steel shall be anchored and placed in accordance with the recommendations as provided by the lining Manufacturer's recommendations.
- C. Install lining according to the Manufacturer's installation guidelines.
 - 1. Adjust the applicator retrieval rate to obtain the minimum lining design thickness.
 - 2. Using a wet gage, verify applied thickness at random perimeter locations at least once every 30 feet during the application process.
 - 3. Immediately apply additional material to any areas found to be less than the design thickness.
 - 4. After lining commences, one sample per every other batch of material shall be collected and analyzed by X-Ray Fluorescence (XRF) by third party independent laboratory for verification of material formulation data as specified herein.
- D. Lining shall transition around any drop inlets, taps or access points. This may include hand spraying or applying by trowel additional material to achieve a uniform and leak free transition.
- E. A curing compound in accordance with ASTM C 309 and the lining Manufacturer's recommendations shall be used.
- F. Obtain cube test samples of the lining material as determined by ENGINEER/OWNER for laboratory testing as described in ASTM C109.
- G. Visually inspect the finished lining to ensure a uniform, leak-free surface.
- H. Conduct video inspection in accordance to Section 33 0134, furnishing a USB drive containing the results of the post-lining inspection to OWNER upon completion of said inspection.

3.06 Testing and Acceptance

- A. Completed lining shall be smooth and free from honeycomb and areas of segregation.
- B. An independent third party ACI certified testing agency shall conduct and report compressive strength testing of the material utilized in the rehabilitation.
 - 1. At a minimum this shall include compressive strength (ASTM C39 or C-109) test, achieving a minimum 8,000 psi at 28 days. Additional samples may be held for retesting at 56 days, if necessary.
 - 2. Testing frequency shall include the first and last day of construction and:
 - a. the more frequent of once for every 40,000 pounds of dry geopolymer material applied, or
 - b. once every other day of application.

- C. Thickness verification may be done with mass balance calculations where the average depth is based on the total volume of material placed and the surface area of application.
- D. Small plastic indicator tabs shall be attached on the structure to verify that the proper thickness is achieved. Indicator tabs are to be positioned just below the specified thickness and are left in place when sprayed over.
- E. In addition, OWNER may request CONTRACTOR to remove a test core from the installed lining, at established intervals. When requested by the OWNER, the lining shall be cored at three different clock positions, and the average thickness measured shall be taken as the actual thickness of the lining. This testing shall be at CONTRACTOR's expense.
 - 1. CONTRACTOR shall mark the core samples with the date that the lining was installed and the date that the core was removed, and the location taken.
 - 2. If a sample is determined to be less than 90% of the specified minimum thickness and or less than 90% of the 28-day compressive and flexural strength, the lining will be considered unacceptable. In this case, CONTRACTOR shall submit a proposed method of repair or replacement for review and approval by ENGINEER/OWNER. Work required to remedy nonconforming work shall be at no additional cost to OWNER.
- F. If it is determined that the geopolymer lining material did not match the submitted Manufacturer's claims, the product is considered unacceptable and non-conforming.
 - 1. CONTRACTOR shall submit proof that the geopolymer lining meets the requirements of the specification through the use of samples analyzed or retained at the manufacturing facility or submit a method for replacement of the lining for review and approval by ENGINEER/OWNER. Work required to remedy non-conforming work shall be at no additional cost to OWNER.
- G. For all instances, where the geopolymer lining is deemed unacceptable as described in this Article, CONTRACTOR shall submit a proposed method of repair or replacement for review and approval by ENGINEER/OWNER. Work required to remedy non-conforming work shall be at no additional cost to OWNER.

3.07 Cleaning

- A. Keep premises free from accumulations of waste materials, rubbish and other debris resulting from the Work.
- B. Remove waste materials, rubbish, and debris from and about premises.
- C. Remove tools, construction equipment and machinery, and surplus materials.
- D. Restore to original condition portions of site not designated for alteration by Contract Documents.

End of Section

Section 33 0513 Manholes and Structures

Part 1 General

1.01 Scope of Work

- A. This Section includes Monolithic concrete manholes with lid frame, covers, anchorage and accessories, as well as modular precast concrete manhole sections with tongue-and-groove joints with masonry transition to lid frame, covers, anchorage and accessories.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200: Unit Prices
- B. Section 04 0511: Mortaring and Grouting
- C. Section 03 3000: Cast-in-Place Concrete
- D. Section 31 2316: Structural Excavation and Backfill
- E. Section 31 2319: Dewatering
- F. Section 31 2333: Trenching and Backfilling
- G. Section 31 7000: Tunneling and Mining

1.03 Requirements of Regulatory Agencies

- A. Conform to the applicable requirements of State and local health authorities having jurisdiction for disinfection and testing of water mains.

1.04 Reference Standards

- A. Unless otherwise specified, the Work of this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. ACI - American Concrete Institute
 - 2. ASTM - ASTM International

1.05 Submittals

- A. Shop Drawings: Indicate manhole and vault locations, elevations, piping, conduit, and sizes and elevations of penetrations.
- B. Product Data: Provide manufacturer's data and installation instructions for precast manhole and vault sections, joint connections, water stops, gaskets, corrosion protection system, flexible pipe joints, chimney seals, manhole and vault castings, and other pertinent information for precast and cast-in-place manholes and vaults.
- C. Manufacturers Certification: Certify that all products furnished meet or exceed the specified requirements, including worst case depth loadings for this project.
- D. Calculations: Submit calculations for review sealed and signed by a registered Professional Structural Engineer in the State of Michigan. Include structural, depth of bury, buoyancy, and all other information necessary to determine adequacy of the item.
- E. Results of manhole and vault leakage and vacuum tests

1.06 Closeout Submittals

- A. The following shall be submitted in accordance with Section 01 7700, Closeout Procedures:
 - 1. Manufacturer's field reports.
 - 2. Project record documents:
 - a. Accurately record actual locations of manholes, connections, and invert elevations.
 - b. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.07 Design Requirements

- A. Equivalent strength: Based on structural design of reinforced concrete as outlined in ACI 318.
- B. Design of Lifting Devices for Precast Structures: In accordance with ASTM C 890 "Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures." Provide lifting inserts designed for four times the anticipated lifting load. Grout inserts in place when complete.
- C. Design of Joints for Precast Structures: Gaskets in accordance with ASTM C 923 "Standard Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals" with maximum leakage of 0.025 gallons per hour per foot of joint at 3 feet of head.
- D. Use precast concrete manholes or vaults designed by the precast manufacturer's registered Professional Structural Engineer, licensed in the State of Michigan in accordance with the Contract Documents. Furnish precast concrete manholes, however, conforming to the following minimum design requirements in addition to the ASTM standards referenced in this Section:
- E. The top slab of all manholes or vaults shall be designed for an H-20 truck loading.
- F. Minimum manhole or vault base slab thickness shall be eight (8) inches up to twenty five (25) feet depth and twelve (12) inches over twenty five (25) feet depth.
- G. Manholes and vaults shall resist buoyancy due to flooding with a high ground water table elevation at the top of the precast concrete structure. The factor of safety against buoyancy shall be 1.20. Buoyancy calculations shall be provided with the submittal.
- H. Walls backfilled with cohesive soil shall be designed for an equivalent horizontal fluid at-rest soil pressure of 135 pounds per square foot (psf) per foot of wall height for walls below the ground water table.
- I. Walls backfilled with granular soil shall be designed for an equivalent horizontal fluid at-rest soil pressure of 125 psf per foot of wall height for walls below the ground water table.
- J. Design walls for surcharge load from adjacent structures or minimum 300 psf surcharge, whichever is greater.
- K. Loads associated with testing manholes and vaults for water-tightness by vacuum testing in accordance with this Section.

1.08 Delivery, Storage and Handling

- A. Comply with precast concrete manufacturer's instructions for unloading, storing and moving precast manholes, vaults and drainage structures.
- B. Store precast concrete manholes, vaults and drainage structures to prevent damage to Owner's property or other public or private property. Repair property damaged from materials storage.
- C. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers shown on Contract Drawings to indicate its intended use.

1.09 Qualifications

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.

Part 2 Products

2.01 Valve Vaults, Manholes, Frames, and Covers

- A. Valve Vaults and Manhole Manufacturers:
 - 1. Northern Concrete Pipe, Inc.
 - 2. Mack Industries
 - 3. ENGINEER-approved equal.
- B. Manhole and Vault Sections: Reinforced precast concrete in accordance with ASTM C478 with gaskets in accordance with ASTM C923.
- C. Benching:
 - 1. Provide full height and poured-in-place benching.
 - 2. Use non-shrink grout as specified in Section 04 0511.
 - 3. Appropriate granular filler may be used, subject to the approval of Engineer.
- D. Watertight Cover and Frame Manufacturers:
 - 1. East Jordan Iron Works, Inc. - Model 1040 ZPT, Type A.
 - 2. Neenah Foundry Co. - Model R-1916-F.
 - 3. ENGINEER-approved equal.
- E. Cover and Frame Product Description:
 - 1. ASTM A48, Class 35B Cast iron construction, machined flat bearing surface, removable, watertight, and boltable lid, 304 stainless steel frame anchors with non-seizing 304 stainless steel nuts, 304 stainless steel bolts for cover, and a cover molded with name and logo per Contract Drawings.

2.02 Storm Sewer Manholes, Frames, and Covers

- A. Storm Sewer Manhole Manufacturers:

1. Northern Concrete Pipe, Inc.
 2. Mack Industries
 3. ENGINEER-approved equal.
- B. Cover and Frame Manufacturers:
1. East Jordan Iron Works, Inc. - Model 1040 ZPT, Type A.
 2. Neenah Foundry Co. - Model R-1916-F.
 3. ENGINEER-approved equal.
- C. Cover and Frame Product Description:
1. ASTM A48, Class 35B Cast iron construction, machined flat bearing surface, removable, watertight, and boltable lid, 304 stainless steel frame anchors with non-seizing 304 stainless steel nuts, 304 stainless steel bolts for cover, and a cover molded with name and logo per Contract Drawings.

2.03 Other Manhole and Vault Components

- A. Steps: Per Contract Drawings.
- B. Base Slab:
1. Per Contract Drawings, cast-in-place concrete of type specified in Section 03301 or integral, monolithically cast precast concrete or standard tee pipe base sections.
- C. Pipe to Manhole/vault Connection:
1. Unless noted otherwise on the Contract Drawings, use a resilient type connector, in accordance with ASTM C-923, to connect pipes to the manhole. Use an A-Lock press wedge, Kor-n-Seal, or Res-Seal connector. No substitutions will be allowed. Non-shrink grout may only be used per the Contract Drawings or with written permission of the Engineer.
- D. Manhole and Vault Chimney Seals:
1. As shown on the Contract Drawings, seal the outside of the manhole or vault cone or riser section to the grade rings and manhole and vault frame with a heat shrinkable wrap or a compressible rubber seal with 304 stainless steel compression bands.
 2. Manufacturers:
 - a. Canusa - WrapidSeal Manhole Encapsulation System.
 - b. Cretex Specialty Products - External Manhole Seal.
 - c. ENGINEER-approved equal.

2.04 Configuration

- A. Shaft Construction: Concentric with eccentric cone top section; lipped male/female gasketed joints; flexible rubber joint to receive pipe.
- B. Shape: Cylindrical.
- C. Clear Inside Dimensions: As indicated on Contract Drawings and as required for construction.

- D. Design Depth: As indicated on Contract Drawings and as required for construction.
- E. Clear Lid Opening: As indicated on Contract Drawings and as required for construction.
- F. Pipe Entry: Provide openings as indicated on Contract Drawings and as required for construction.
- G. Steps: As indicated on Contract Drawings and required by applicable safety code.

2.05 Bedding and Cover Materials

- A. Structure and Pipe Bedding: Fill Type A1, A2 or A5 as specified in Section 31 2333 and on the Contract Drawings.
- B. Topsoil Fill Type: S3 or S4 as specified in Section 31 2333 and on the Contract Drawings.
- C. Soil Backfill from Above Pipe to Finish Grade: Soil Type S1 or S2, as specified in Section 31 2333 and on the Contract Drawings.

Part 3 Execution

3.01 Examination

- A. Verify items provided by other sections of Work are properly sized and located.
- B. Verify that built-in items are in proper location, and ready for roughing into Work.
- C. Verify excavation for manholes or vault is correct.

3.02 Preparation

- A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.
- B. Do not install structures where site conditions induce loads exceeding structural capacity of structures.
- C. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage. Remove and replace damaged units.
- D. Prepare manhole or vault for installation of chimney seals per manufacturer's instructions.

3.03 Installation

- A. Excavation and Backfill:
 - 1. Excavate for manholes, vaults and drainage structures in accordance with Section 31 2316 in location and to depth shown. Provide clearance around sidewalls of structure for construction operations.
 - 2. When groundwater is encountered, prevent accumulation of water in excavations. Place manholes, vaults or drainage structures in dry trench.
 - 3. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation.
 - 4. Placement and compaction of surrounding backfill material shall be accomplished to provide sufficient and equal side pressure on the manhole or vault.

- B. Backfill excavations for manholes, vaults and drainage structures in accordance with Section 31 2316.
- C. Form and place manhole cylinder or vault wall plumb and level, to correct dimensions and elevations.
- D. Connect pipe with flexible rubber joints as shown on the Contract Drawings.
- E. Set cover frames and covers level without tipping, to correct elevations.
- F. Install chimney seals per manufacturer's instructions and Contract Drawings.
- G. Coordinate with other sections of Work to provide correct size, shape, elevation, and location.
- H. Use manufacturer's recommended method, procedure and equipment for handling, installing, and connecting the manholes or vaults.

3.04 Standard Precast Concrete Manhole, Vault and Drainage Structure Installation

- A. Prepare granular bedding as shown on Drawings, to receive integral, monolithically cast base slab as specified.
- B. Lift precast structures at lifting points designated by manufacturer. Grout all lifting holes when structure is in place.
- C. When lowering manholes, vaults and drainage structures into excavations and joining pipe to units, take precautions to ensure interior of pipeline and structure remains clean.
- D. Set precast structures bearing firmly and fully on granular bedding, compacted in accordance with provisions of Section 02320 or on other support system shown on Contract Drawings.
- E. Assemble multi-section structures by lowering each section into excavation. Lower, set level, and firmly position base section before placing additional sections.
- F. Remove foreign materials from joint surfaces and verify gaskets are installed properly.
- G. Maintain alignment between sections by using guide devices affixed to lower section.
- H. Verify manholes, vaults and drainage structures installed satisfy required alignment and grade.
- I. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe. Connect pipe to manhole or vault with a flexible rubber joint as specified. Fill annular space with mortar.
- J. Cut pipe to finish flush with interior of structure.
- K. Shape inverts through manhole or vault as shown on Contract Drawings. Provide cast-in-place full height benching. Trowel smooth and slope to drain per Contract Drawings.

3.05 Castings Installation

- A. Set frames using a precast concrete grade ring with butyl rope to seal joint. Use grade ring sizes per Contract Drawings
- B. Unless Contract Drawings indicate otherwise, set frame and cover 6 inch above finished grade for manholes, vaults and other structures with covers located within unpaved areas to allow area to be graded away from cover beginning 1 inch below top surface of frame.
- C. Set frame and cover flush with ground surface for manholes, vaults and other structures located within paved areas.

3.06 Leakage Testing For Manholes and Vaults

- A. After completion of manhole or vault construction, inspect all manholes for leakage and repair all visible leaks.
- B. After repairing all leaks, test manholes and vaults for water-tightness using vacuum testing procedure as follows:
 - 1. Temporarily plug the influent and effluent lines with suitably sized pneumatic or mechanical plugs. Ensure plugs are properly rated for the pressure required for the test. Place plugs a minimum of 6 inches outside the manhole or vault walls. Brace inverts to prevent lines from being dislodged.
 - 2. Install vacuum tester head assembly at the top access point of the manhole or vault and adjust for a proper seal. Following manufacturer's instructions and safety precautions, inflate sealing element to the recommended maximum inflation pressure. Do not over-inflate.
 - 3. Evacuate manhole or vault with vacuum pump to 10-inches of mercury (Hg). Disconnect the pump and monitor vacuum for the time period specified in the following table:

Vacuum Test Timetable

Depth (feet)	Test Duration (seconds)			
	48-inch Diameter Manhole**	60-inch Diameter Manhole**	72-inch Diameter Manhole**	96-inch Diameter Manhole**
4	30	30	30	30
8	30	30	32	38
12	30	39	48	57
16	40	52	64	76
20	50	65	80	95
24	60	78	96	114
Each 2' more	+5	+6.5	+8	+9.5

** Use equivalent volume for testing vaults

- 4. If the drop in vacuum exceeds 1-inch of mercury (Hg) over the specified time period, locate the leaks and complete repairs necessary to seal the manhole or vault. Repeat the test until acceptable results are obtained.

3.07 Field Quality Control

- A. Test concrete in accordance with Section 03 3000.
- B. Vertical Adjustment of Existing Manhole and Drainage Structures:
 - 1. Where required, adjust top elevation of existing manholes and drainage structures to finished grades shown on Drawings.
 - 2. Reset existing frames, grates, and covers, carefully removed, cleaned of mortar fragments, to required elevation in accordance with requirements specified for installation of castings.
 - 3. Remove concrete without damaging existing vertical reinforcing bars when removal of existing concrete wall is required. Clean vertical bars of concrete and bend into new concrete top slab or splice to required vertical reinforcement, as indicated Drawings.
 - 4. Clean and apply sand-cement-bonding compound on existing concrete surfaces to receive cast-in-place concrete in accordance with Section 03 3000.

End of Section

Section 33 1100

Water Utility Distribution Piping

Part 1 General

1.01 Scope of Work

- A. This Section includes water main Work complete with water main piping, valves, hydrants, thrust blocks, valve wells, structures, fittings, joints, joint materials, nuts, bolts, glands, gaskets, plugs and accessories as shown and required. This Section also includes bedding and laying of water main piping, hydrostatic testing of new water main piping systems, and flushing and chlorination of water main piping systems.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200: Unit Prices
- B. Section 31 2316: Structural Excavation and Backfill
- C. Section 31 2319: Dewatering
- D. Section 31 2333: Trenching and Backfilling
- E. Section 33 0130: Water Utility Leak Testing & Disinfection

1.03 Requirements of Regulatory Agencies

- A. Conform to the applicable requirements of State and local health authorities having jurisdiction for disinfection and testing of water mains.

1.04 Reference Standards

- A. Unless otherwise specified, the Work of this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. ANSI - American National Standards Institute
 - 2. ASTM - ASTM International
 - 3. AWWA - American Water Works Association
 - 4. MDOT - Michigan Department of Transportation, Standard Specifications for Construction, latest edition
 - 5. NSF - National Sanitation Foundation

1.05 Submittals

- A. Tabulated Laying Schedule:
 - 1. Tabulated Laying Schedule, showing stationing, deflection, elevation, slope and description of pieces (i.e., pipe size and material; fitting type, size and material; valve type and size, etc.) shall be submitted to ENGINEER. Pipe manufacture shall not be started until the laying schedule has been reviewed by ENGINEER.
- B. Product Data:

1. Submit catalog data showing pipe sizes, and manufacturing standards, as well as design calculations for internal pressure, vacuum and external load conditions, for both non-restrained and restrained joints.
- C. Schedule of Corporation Stops (Tapping Outlets):
1. A complete schedule of tapping outlets installed in water main piping shall be kept by CONTRACTOR and submitted to ENGINEER at the end of each water main piping section of the Project or on the last day of each week, whichever occurs first.
- D. Quality Assurance Materials:
1. Quality assurance test procedures, test reports for pipes, specials and fittings shall be submitted to ENGINEER.
- E. Affidavits:
1. Affidavits of compliance with the Contract Documents shall be submitted to ENGINEER and shall include the following, where applicable:
 - a. Pipes, specials and fittings (AWWA C200).
 - b. Cement-mortar protective lining (AWWA C205 and AWWA C602).
 - c. Tape coating for the exterior (AWWA C214 and AWWA C209).
 - d. Shrink wrap for exterior (AWWA C216).
 - e. Paint system for the exterior (AWWA C210, C218 or C222).
 - f. Manufacturer's standard repair procedures.
 - g. Manufacturer's written quality control procedures.
 - h. Manufacturer's Installation Instructions: Indicate special installation requirements.
 - i. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.
 2. Affidavits for items a through e shall be signed by an authorized professional.

1.06 Closeout Submittals

- A. The following shall be submitted in accordance with Section 01 7700, Closeout Procedures:
1. Manufacturer's field reports.
 2. Project record documents:
 - a. Accurately record actual locations of piping mains, valves, connections, and invert elevations.

- b. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.
- 3. Provide a final record laying schedule.
- 4. Submit certified copies of hydrostatic test results of completed force main sections as specified in Article 3.15.

1.07 Storage of Materials

- A. Pipe shall be stored in a manner to minimize infiltration of dirt, debris and other extraneous materials.
- B. Piping materials shall not be stacked higher than four (4) feet (1.2 m). Suitable racks, chairs and other supports shall be provided to protect preformed pipe mating surfaces from damage. Store bottom tiers off the ground, alternate tiers and chock tier ends.
- C. Store hydrants, valves, wells and prefabricated structures off the ground, drained and kept free of water to protect against damage from freezing. Hydrants, valves, wells, their accessories and appurtenances shall be kept in their original containers until ready for installation.
- D. Gaskets, glands, joint and sealing materials subject to ultra-violet or ozone attack shall be protected from the sunlight, atmosphere and weather; and stored in suitable enclosures until ready for installation.

1.08 Handling of Materials

- A. Load and unload piping using suitably approved hoists and skidding. Piping shall not be dropped, bumped or allowed to impact against itself. Damaged piping shall be rejected by CONTRACTOR.
- B. Lifting devices shall be suited to the Work and shall protect surfaces from damage.

Part 2 Products

2.01 Scope

- A. It is the intent of the Articles in Part 2 of this specification section is to specify in detail the various types of pipe, joints, and fittings which have been indicated throughout the Plans and Specifications.
- B. These Articles shall not be construed as allowing any alternate type of material to that which is indicated on the Plans or elsewhere in the Specifications.

2.02 Ductile Iron Pipe System

- A. Ductile Iron Pipe shall be ANSI/AWWA C151/A21.51, with cement mortar lining inside, and 1-mil (25 µm) minimum thickness asphaltic coating outside. Pipe shall have a minimum wall thickness class for the pipe nominal inside diameter as indicated on the Plans or specified in the Proposal.
- B. Mechanical joints for ductile iron pipe shall be compression gasket type, conforming to ANSI/AWWA C111/A21.11 except that slots with the same width as the diameter of the bolt holes in mechanical joints shall not be allowed in the bell flange.

- C. Push-on, compression gasket type joints shall conform to ANSI/AWWA C111/A21.11 with spigot of pipe marked to visually determine when the spigot is fully seated in the bell of the adjoining section.
- D. Fittings and plugs shall be ductile iron compact fittings, mechanical joint, pressure rating of 350 psi (2.4 MPa), conforming to ANSI/AWWA C153/A21.53, and rubber gasket joints conforming to ANSI/AWWA C111/A21.11, with double thickness cement mortar lining and coal tar enamel coating on the outside of fittings.
- E. Flexible ball and retainer type joints shall be ball and retainer type, boltless, locking, and capable of being deflected up to 15°.
- F. Cement mortar linings for ductile iron pipe shall conform to the requirements of ANSI/AWWA C104/A21.4 of the thickness specified and shall be permanently set prior to the application of any additional pipe coating.

2.03 Prestressed Concrete Pressure Pipe Systems

- A. Concrete piping shall be prestressed concrete, embedded cylinder type, 175 psi (1.2 MPa) plus d-load design pressure conforming to AWWA C301. Seal coat in accordance with ANSI/AWWA C104/A21.4 as applicable.
- B. Joints for concrete pipe shall be push-on, steel ring, gasket type conforming to AWWA C300 or AWWA C301.
- C. Fittings shall be AWWA C300, Type A, concrete or mortar lined with reinforced concrete or mortar exterior covering. AWWA C300, Type B, cut and welded steel plate, mortar coated on interior and exterior.
- D. Seal coat concrete pipe with bitumastic concrete penetrant conforming to ANSI/AWWA C104/A21.4. Apply after pipe has cured.

2.04 Polyvinyl Chloride (PVC) Piping Systems

- A. Rigid polyvinyl chloride bell and spigot type pressure pipe and couplings, size four (4) inches (100 mm) and larger, shall conform to AWWA C900, pressure class 235, DR 18 unless otherwise indicated in the Contract Documents. Rigid polyvinyl chloride bell and spigot type pressure pipe and couplings, smaller than four (4) inches shall be ASTM D2241, SDR 21, pressure class 200.
- B. Molecularly oriented polyvinyl chloride (PVCO) pipe sizes 4-inches through 24-inches shall be AWWA C909, pressure class 200 unless otherwise indicated in the Contract Documents. PVCO pipe will only be allowed when specifically called for in the Contract Documents.
- C. Compounds used for production of PVC pipe and components shall be suitable for potable water products as required in NSF 14 and ANSI/NSF 61. Spigot end of pipe shall be marked to visually determine when the spigot is fully seated in the bell of the adjoining pipe.
- D. Joints for PVC pipe shall be push-on or mechanical elastomeric gasket type, conforming to ASTM D3139.
- E. PVC fittings shall only be allowed when called for on the Plans. When allowed, 4-inch and larger PVC fittings and plugs shall be 200 pound (1380 kPa) Pressure Class conforming to AWWA C900 of types and sizes indicated on the Plans. PVC fittings smaller than 4-inches, when allowed, shall be ASTM D2241.

- F. Fittings and plugs for PVC pipe, unless specified otherwise, shall be ductile iron and as specified in Article 2.02.
- G. Gaskets for PVC pipe shall be elastomeric seal type conforming to ASTM F477.
- H. Pipe joint lubricants shall be manufacturers standard nontoxic conforming to AWWA C900.

2.05 Restrained Joints

- A. Where the Plans or Specifications call for restrained joints they shall be per the following.
 - 1. Restrained joints for ductile iron pipe and fittings shall be designed for a working pressure of 350 psi (2.4 MPa). Joints shall be capable of being deflected after assembly. Restraints shall be by one of the following methods:
 - a. A positive axial lock between the bell interior surface and a retainer welded on the spigot end of the pipe.
 - b. A thrust restraint wedge which embeds in the pipe with twist off nuts to control wedge setting.
 - 2. Restrained joints for PVC water main pipe shall be designed for a working pressure of 200 psi (1.4 MPa). Where the restrained portion of the pipe is connected to fittings, restraint shall be provided across the joint by a clamping ring and anchored to the fitting with T-head bolts or stainless steel rods.
 - 3. Restraining devices for PVC water main pipe shall incorporate clamping rings with serrations on the inside surface to provide positive restraint on the outside surface of the pipe and shall provide full support around the circumference of the pipe to maintain roundness.

2.06 Polyethylene Encasement

- A. Polyethylene material for encasement shall be either 4 mil high density, cross-laminated polyethylene film or 8 mil linear low-density polyethylene film per AWWA C105.

2.07 Hydrants

- A. Fire hydrants shall equal or exceed AWWA C502 Specifications and shall be in compliance with OWNER's standards.
- B. Hydrants shall have a main valve opening of 5-1/4" and a 6" inlet connection. Each hydrant shall have two (2) 2-1/2" national standard hose connections and one (1) 4 1/2" national standard pumper connection.
- C. Each hydrant shall be furnished complete with one 6" auxiliary gate valve and box.
- D. The hydrant inlet joints and auxiliary valve joints shall be push-on type or mechanical joint for standard hydrants and mechanical type for Type P hydrants.
- E. Standard hydrant leads shall consist of pipe material as used for water main construction:
 - 1. Type P hydrant leads shall consist of anchoring couplings (F-1215) and anchoring pipe with one end solid gland and the other Roto-Right gland (F-1218) by Clow, and standard mechanical fittings where applicable.

2. TCIW-MJ hydrant tee with fittings, clamps and rods, or equal may be substituted.

2.08 Valves

A. General:

1. Valves, operation, accessories, and specific notes are specified on the drawings. Valve materials and workmanship shall conform to applicable ANSI, ASTM, and AWWA standards. Valve bodies shall have an arrow to indicate direction of turning to open.

B. Swing Check Valve (2-1/2 inch and larger):

1. General:

- a. Swing check valves shall be the rubber flapper type with a heavily constructed cast iron body and cover in accordance with ASTM A296.
- b. The body shall be long pattern design (not wafer), with integrally cast-on end flanges.
- c. Check valves to have full pipe size flow area.
- d. Seating surface to be on a 45° angle requiring the flapper to travel only 35° from closed to full open position, for minimum head loss and non-slam closure.
- e. The valve shall be designed to also function in the vertical position.

2. Flapper:

- a. The flapper shall be Buna-N having an "O" ring seating edge and be internally reinforced with steel.
- b. Flapper to be captured between the body and the body cover in a manner to permit the flapper to flex from closed to full open position during flow through the valve.
- c. Flapper shall be easily removed without need to remove valve from line.
- d. Flapper shall have an elastic spring, molded internally, to assist the flapper to close against a slight head to prevent slamming.

3. Exterior Paint: Phenolic Primer Red Oxide (NSF Approved)

4. Manufacturer: Valve shall be Crispin, Val-Matic, Clow, or equal.

C. Wafer Style Check Valves:

1. General:

- a. Silent or double door spring loaded check valves shall be compact wafer style, designed to fit between ANSI flanges.

- b. Valves shall be sized as shown on Drawing for low pressure air, with a working pressure of 150 psi
 - c. Check valve shall be spring loaded, normally closed by means of one or more heavy duty stainless steel torsion springs.
 - d. Flow from the blowers shall cause the valve to open and upon blower shut down, the torsion spring will shut the valve before reverse flow starts and at a point of zero velocity of non-slam closure.
 - 2. Materials:
 - a. The sealing element shall be BUNA-N molded to body.
 - b. Valve body shall be fabricated of cast iron.
 - c. Torsion spring, hinge shaft and stop pin shall be constructed of stainless steel.
 - d. Silent plug or doors shall be bronze, ASTM B584.
 - 3. Manufacturer: Valves shall be Val-Matic, Mission, or equal.
- D. Ball Check Valves:
- 1. Provide PVC Ball Check Valve with socket union connections, true union design, ball check type, Viton O-rings and seat, rated for 150 psi at 73°F.
 - 2. Manufacturer: Valves shall be NIBCO, Inc., Hayward Industrial Products, Inc, or approved equal.
- E. Ball Valves:
- 1. Manufacturer: Valves shall be Apollo Conbroco, Jamesbury Series 500 Chemtrol, Howard, or equal.
 - 2. Ball valves have a working pressure of 200 psig, except PVC which is 150 psig, drop tight shut off, full port material bronze body, hard chrome plated ball teflon or viton seats and/or 316 stainless steel body and ball, teflon seats and/or PVC body and ball teflon seats depending on the service, with stops at full open and full closed.
- F. Plug Valves:
- 1. General:
 - a. Plug valves shall be of the non-lubricated eccentric type with resilient faced plugs and shall be furnished with end connection as shown on the plans. Flanged valve shall be faced and drilled to the ANSI125/150 lb. standard.
 - 2. Bodies:
 - a. Valve bodies shall be of ASTM A126 Class B cast iron. Bodied in 4" (100mm) and larger valves shall be furnished with a 1/8" welded overlay seat of not less than 90% pure nickel. Seat areas shall be raised, with raised surface completely covered with weld to insure that the plug face contacts only nickel. Screwed in seats are not acceptable.

3. Plugs:

- a. Plugs shall be of ASTM A126 Class B cast iron. The plugs shall have a cylindrical seating surface eccentrically offset from the center of the plug shaft. The interface between the plug face and body seat, with the plug in the closed position, shall be externally adjusted in the field with the valve in line under pressure. Plug valves shall be chloroprene (CR) or resilient facing suitable for application.

4. Bearings:

- a. Bearings shall have sleeves type metal bearings and shall be of sintered, oil impregnated permanently lubricated type 316 ASTM A743 Grade CFB ½" – 36" sizes. Non-metallic bearings shall not be acceptable.

5. Shaft seals:

- a. Shaft seals shall be of the multiple V-ring type and shall be externally adjustable and re-packable without removing the actuator or bonnet from the valve under pressure. Valves utilizing O-rings or non-adjustable packing shall not be acceptable.

6. Pressure Rating:

- a. Pressure rating shall be 175 psi on sizes ½" – 12" and 150 psi for 14" – 72". Every valve shall be given a hydrostatic and seat test, with test results being certified.
- b. Manual valves shall have lever or gear actuators and tee wrenches, extension stems, floor stand, etc., as indicated on the plans. All 6" valve and larger shall be equipped with gear actuators.
- c. Gearing shall be enclosed in a cast iron housing and be suitable for running in a lubricant with seals provided on all shaft to prevent entry of dirt and water into the actuator.
- d. The actuator shaft and the quadrant shall be supported on permanently lubricated bronze bearings. Actuators shall clearly indicate valve position and adjustable stop shall be provided to set closing torque and to provide adjustment to compensate for change in pressure differential or flow direction change.
- e. Exposed nuts, bolts and washers shall be zinc plated.
- f. Power actuated valves shall be furnished with electric motor actuators as indicated on the plans.

7. Manufacturers: Valves shall be the product of DeZurik or engineer approved equal.

G. Butterfly Valves (Cast Iron):

- 1. Butterfly valves shall be rubber-seated tight closing and shall conform to AWWA Standard C504 latest revision.
- 2. Class 150 Valves (Non-Cyclic Applications).

3. Valves shall be of the flangeless wafer body style. All valves shall be suitable for use with ANSI 150 pound flanges. Bodies shall be cast iron. Valves shall be rated at 175 psi. Bodies of all flangeless wafer valves shall have bolt guides to center the body in the pipeline.
4. Valves shall be furnished with self-lubricated bearings of TFE coated stainless steel. Shaft seals shall be provided to prevent leakage and to protect bearings from internal or external corrosion.
5. Valve seats shall be of the reinforced resilient type and shall be field replaceable. Seats shall also act as a body liner to prevent flow from contacting the body casting. Seats shall have flange sealing to provide a positive seal without use of flange gaskets. Seats shall be of Buna-N or EPDM suitable for use with potable water. Shafts shall be one piece and shall be 316 stainless steel. Shaft diameter shall be suitable for the service conditions specified.
6. Shafts shall be finish ground to minimize bearing and shaft seal wear. Shafts of 12-inch and larger shall have a non-adjustable thrust collar. Shaft seals shall have a stuffing box and pull down packing gland. Packing shall be furnished with self-adjusting "V" type packing.
7. Discs shall be aluminum bronze. The disc-to-shaft connections shall be Type 316 stainless steel.
8. Pins, shaft, and disc of all valves shall be individually machined and completely interchangeable.
9. Valves shall be available with field interchangeable manual or powered actuators as required. The actuator-to-shaft connection shall be designed to shear and prevent internal valve damage if the disc closes on foreign material in the pipeline.
10. Factory Testing: Test shall be conducted on each valve in accordance with Manufacturer's Quality Control procedures.
11. Butterfly valves shall be marked with the valve size, manufacturer's mark, year of manufacture, and class.
12. Manufacturer: Valves shall be DeZurik, Val-Matic, Clow or equal

H. Gate Valves:

1. Gate valves 2 inches in diameter or larger shall be iron-body, bronze mounted, inside-screw, hand-operated resilient seat, and shall be equipped with rubber O-Ring Seals at the top of the stems unless otherwise shown on the plans. Valves shall conform to the requirements of AWWA Specification C500, except as such specifications are herein modified. Gate valves shall be designed for minimum working pressure of 200 psi.
2. Valves smaller than 3 inches in diameter shall have threaded connections, unless shown otherwise on the plans. Valves three inches (3") in size and larger, shall have mechanical joints for use underground and shall have flanged joints if they are to be installed in structures. Flanges for pressure ratings shall be faced and drilled to comply with ANSI Specifications A21.15.

3. Wedge shall be of cast iron completely encapsulated with rubber. The sealing rubber shall be permanently bonded to the cast iron wedge to meet ASTM tests for rubber metal bond ASTM D-249.
4. Valves shall be supplied with O-Ring Seals at all pressure retaining joints. No flat gaskets allowed.
5. Gate valves shall be hand operated and designed to turn left or counter-clockwise to open with 2" square operating nut or handwheel with the word "Open" and an arrow cast in the metal to indicate direction of opening.
6. Suitable extension stems or operating keys shall be furnished to properly operate all valves installed with valve boxes, and all necessary guides and supports for valve stems shall be furnished and installed where required.
7. Gate valves installed underground shall be equipped with standard cast iron valve boxes unless otherwise shown on the plans. Where valves are shown to be of smaller diameter than the connecting piping the two reducers required shall be included as fittings.
8. CONTRACTOR shall submit to ENGINEER complete catalog information showing principal dimensions, weights, and specifications and operating data for all valves he proposes to finish.
9. Body and bonnet shall be coated with fusion bonded epoxy both interior and exterior, complying with AWWA C-550 and be NSF 14 and NSF 61 approved.
10. Each valve shall have maker's name, pressure rating, and year in which manufactured cast on the body. Prior to shipment from factory, each valve shall be tested by hydrostatic pressure equal to requirement for both AWWA requirements. Bolting shall either be regular plated or stainless steel type 304/316, as required.
11. Valves shall be as manufactured by Mueller Company, Clow Valve Company, or ENGINEER-approved equal. Valves shall be backed by manufacturer's five-year limited warranty.

I. Altitude Valves:

1. Altitude level control valve shall be cast iron, ASTM A 126-CLB, globe body design, and fully bronze mounted. Valve shall be ANSI B16.1, Class 125 flanged ends, and shall be constructed with complete bronze lining, bronze valve seat and piston. Furnish with external controls, including piping and regulating valves.
2. Valve shall be designed for installation in the influent piping to a water storage tank to prevent tank overflow and to maintain the water level within the tank within a variation of six inches of depth.
3. Altitude valves shall be one of the following types:
 - a. Type 1: Closes at the high water level, and opens for return flow when pressure at the valve inlet is less than the storage tank pressure.
 - b. Type 2: Closes at the high water level, and/or return flow, delays on opening until pressure at the valve inlet lowers to a selected pressure.

- c. Type 3: Closes at the high water level, water is withdrawn from the storage tank through a separate line. The valve opens to refill the tank when the water level lowers approximately six inches below shutoff point. The valve shall not allow loss or return of storage water through the valve.
 - d. Type 4: Closes at the high water level, water is withdrawn from the storage tank through a separate line. The valve delays on opening until water in the reservoir lowers to a desired low level. Low level shall be adjustable 1 to 15 feet from high water shutoff point. The valve shall not allow loss or return of storage water through the valve.
4. Acceptable manufacturers include Cla-Val, Golden Anderson, OCV Control Valves, Ross Valve, Singer, or approved equal.

J. Air Release Valves:

- 1. Air Release valves shall have an ASTM A126 Class B cast iron body and cover with a threaded inlet connection of the size shown on the plans or listed in the schedule and a 1/2 inch NPT outlet connection. Valve body shall have a 2 inch NPT plugged port near the base to facilitate cleanout of large solids as well as a 1/2 inch NPT connection near the top and 1 inch NPT port near the bottom to permit the installation of flushing attachments.
- 2. Valves shall have an 18-8 stainless steel float and a replaceable seat of Buna-N or other suitable material. Internal linkage mechanism shall be 18-8 stainless steel, plastic or bronze is not acceptable. The linkage mechanism shall be capable of being removed from the cover without disassembly of the mechanism. Valves shall have 3/16 in. diameter stainless steel orifice for working pressures up to 150 PSI. Valve shall close drop tight.
- 3. The valve shall automatically exhaust accumulated air from a fluid system while the system is pressurized and operational.
- 4. For valves installed below grade, each valve shall be equipped with a flood safe kit to prevent inflow into the valve during submerged conditions.
 - a. Cover, and upper/lower chamber shall be constructed of ductile iron and conform to ASTM A536, Grade 65-45-12 with internal and external FBE coating.
 - b. Upper and lower seats shall be resilient in accordance with ASTM D2000.
 - c. Float checks shall be constructed of Type 316 stainless steel in accordance with ASTM A240.
 - d. Nuts and bolts shall be constructed of Type 316 stainless steel in accordance with ASTM F593.
 - e. Basket retainer shall be Type 304 stainless steel in accordance with ASTM F879; basket shall be Type 304 stainless steel in accordance with ASTM A240.
- 5. Air release valves shall be Golden Anderson, Val-Matic or equal.

2.09 Tapping Sleeves

- A. Tapping Sleeves shall be cast iron or ductile iron, pressure rating of 250 psi (1.7 MPa), mechanical joint sleeves conforming to AWWA C153, furnished complete with valve, stops, caps, plugs and joint accessories as indicated on the Plan. The sleeve shall be of a 2-section type.

2.10 Valve Boxes

- A. Valve boxes shall be 3-piece, 5-1/4 inch (135 mm) diameter, screw type, gray iron castings consisting of base section, bottom section, and top section with lid, conforming to ASTM A48, Class 20. Overall length shall be adjustable to meet grade.

2.11 Corporation Stops

- A. Corporation stops, couplings and plugs shall be water service bronze of type and size detailed on the Plans.

2.12 Service Saddles

- A. Water service saddles shall be compatible with the main and service lead, with straps of a ductile material to avoid crushing the main out-of-round. A molded gasket of rubber or neoprene shall completely encircle the tapped opening to insure a watertight connection. The use of lead gaskets is not allowed. Water service saddles shall be bronze with AWWA tapped threads.
- B. Service saddles used with PVC water main shall be double strap, full circular and provide uniform bearing around the circumference. U-bolt type straps are not allowed.

2.13 Curb Stops

- A. Water service bronze of types and sizes detailed on the Plans. Curb stops shall include an extension type, 3-piece curb box with extension type base, foot piece, one piece lid and a 3-foot stationary rod, unless otherwise specified.

2.14 Threaded Fittings

- A. Where indicated on the Plans, threads for water main service fittings shall conform to the requirements of AWWA C800 and AWWA C800 "Appendix for Materials."

2.15 Water Service Pipe

- A. Soft Copper shall be Type "K" conforming to ASTM B-88, with flared fittings.
- B. Polyvinyl Chloride shall conform to ASTM D2241 or D1785 Schedule 40.

2.16 Restraints, Clamps, Rods, and Ties

- A. High strength low alloy steel or stainless steel conforming to ANSI/AWWA C111/A21.11. Balls and fittings shall be bronze alloy or corrosion protected steel.

2.17 Structures

- A. Material for water main structures shall conform to the details on the plans and the requirements listed below:

1. Concrete brick shall be ASTM C55, Grade S-II, solid units of nominal 3-inch (75 mm) thickness.
2. Concrete block shall be ASTM C139 shape and scored as detailed and as approved.
3. Precast concrete structures shall conform to ASTM C478, circular with circular reinforcement as detailed. Provide lifting holes in precast units where indicated.

2.18 Manhole Steps

- A. Cast iron manhole steps shall be ASTM A48, Class 30, with a minimum cross section dimension of 1-inch (25 mm) in any direction.
- B. Steel reinforced plastic manhole steps shall be suitably approved co-polymer polypropylene conforming to ASTM D4101, PP0344B33534Z02 with 1/2 inch (12 mm) minimum diameter deformed reinforcing bar conforming to ASTM A615, Grade 60.
- C. Manhole steps shall be of types and sizes indicated on the Plans and shall comply with applicable state and federal occupational and safety standards.

2.19 Covers and Frames

- A. Structure frame and covers shall be of the types and sizes as detailed on the Plans. Covers shall be Class 30, ASTM A48 gray iron castings. Castings shall be neatly made and free from cracks, cold sheets, holes and other defects. Surfaces of castings shall be ground to assure proper fit and to prevent rocking. Units shall be frost proof and shall be provided with tapping screws and anchors where indicated on the Plans.

2.20 Bolts, Studs, and Nuts

- A. Bolts, studs, and nuts shall be as specified on the Plans and shall conform to the requirements of ANSI/AWWA C111/A21.11 and the ASTM standards listed below:
 1. Bronze: ASTM B98
 2. Steel: ASTM A307, Grade B
 3. Cadmium Plating: ASTM B766, Grade NS
 4. Zinc Coating: ASTM A153 or B633, Type GS
- B. Tee head bolts and nuts shall be high strength, low alloy steel conforming to ANSI/AWWA C111/A 21.11.

2.21 Flowable Fill

- A. Materials:
 1. Cement: Cement shall conform to ASTM C150 or ASTM C595
 2. Fly Ash: Fly ash shall have a maximum loss on ignition of 12 percent and meeting the other requirements of ASTM C618 (Class F)
 3. Water: The water shall meet the requirements of ASTM C94
- B. Mixture (Strength 50-100 psi) (345 to 690 kPa):
 1. Fly Ash: 2,000 lbs/cyd (1190 kg/m³) (min)

2. Cement: 100 lbs/cyd (60 kg/m³)(minimum)
 3. Water: Sufficient water to produce the desired flowability (approximately 700 lbs/cyd)(415 kg/m³)
- C. Temperature of the flowable fill mixture as manufactured and delivered shall be at least 50°Fahrenheit (10° Celsius).
 - D. Flowable fill can be mixed by pugmill, central concrete mixer, ready mix truck, turbine mixer, or other acceptable equipment or method for filling abandoned Water Mains.
 - E. CONTRACTOR shall submit a history of the mix design for 7 day and 28 day strengths, together with any other technical information. The design mix shall also be included as part of CONTRACTOR's submittals for project.

2.22 Tracer Wire

- A. Copper clad steel wire with 30 mil High Density Polyethylene insulation. Concentric copper cladding metallurgically bonded to a steel core through a continuous solid cladding process.
- B. Copper cladding to measure 3% minimum of the overall wire diameter. Wire to be 12 AWG, 0.0808 inches in diameter, 0.00242-inch nominal copper thickness, 9.5270 ohms nominal resistance per 1,000 feet, 675 pounds breaking strength. Wire to be Copperweld ® or equal.

2.23 Acceptable Manufacturers

- A. Flexible Joint Pipe: Acceptable manufacturers include "F141," Clow, "Usiflex," U.S. Pipe, or equal.
- B. Restrained Joints: Acceptable manufacturers for restrained joints for ductile iron pipe include Griffin Pipe Products Company, "Snap-Lok" or "Bolt-Lok"; American Cast Iron Pipe Company, "Lok-Ring" or "Lok-Fast"; United States Pipe and Foundry Company, "TR Flex"; EBBA Iron "Megalug" or ENGINEER-approved equal.
 1. Manufactured in accordance with ANSI/AWWA C111.
 2. A tightly adherent, corrosion resistant coating shall be used on all exposed metal components of the restrained joint system.
 - a. Wedges, actuating hardware or other exposed threaded components shall be coated with a minimum of two (2) coats of fluoropolymer epoxy coating that has been heat cured.
 - b. Primary restraint castings shall be coated with a polyester coating, electrostatically applied and fusion bonded.
 - c. Bolts, nuts, and washers shall be manufactured of low-alloy steel conforming with the material characteristics listed in ANSI/AWWA C11 and shall have a minimum of two (2) coats of fluoropolymer epoxy coating that has been heat cured.
- C. Valve Boxes: Acceptable manufacturers include: "A-295 Three Piece Screw Type," Traverse City Iron Works; "F2450," Clow, "Series 6860, Tyler," or equal.

- D. Corporation Stops: Acceptable manufacturers include: Hays; Crane; Mueller; Ford; or equal.
- E. Service Saddles: Acceptable manufacturers include: "Twin Seal," Clow, "Hays Seal," Hays, "Service Saddles," Mueller, or equal.
- F. Curb Stops: Acceptable manufacturers include: Hays, Ford, Mueller, or equal.

Part 3 Execution

3.01 CONTRACTOR's Verification

- A. Prior to the installation of any water main piping or materials, examine all trenches and other excavations for the proper grades, lines, levels and clearances required to receive the new Work.
- B. Ascertain that all excavation bottoms, compacted subgrades and pipe bedding are adequate to receive water main materials to be installed. Correct defects and deficiencies before proceeding with the work.
- C. Expose the existing water main piping and structures to which the new Work is to be connected and notify ENGINEER of the same. ENGINEER will verify the vertical and horizontal locations of the existing system and shall inform CONTRACTOR as to the necessary adjustments required to align the new water main work with the existing system.

3.02 Preparation

- A. Remove lumps, blisters and excess coatings from the socket and plain ends of pipe. Wire brush and wipe clean the outside surfaces of plain ends and the inside surfaces of socket ends before installation. Any pipe or fitting which has acquired a coating of mud or other foreign material shall be scrubbed clean with heavily chlorinated water.
- B. Pipe fittings, valves, hydrants, accessories and appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective or damaged materials shall be rejected and removed from the Project by CONTRACTOR.

3.03 Installation - General

- A. Foreign matter shall be prevented from entering the pipe while it is being placed in the trench. During and after laying operations, no debris, clothing or other materials shall be placed in the pipe.
- B. During the progress of water main Work, watertight plugs shall be carried along and inserted in the end of each pipe as it is laid to prevent foreign matter or rodents from entering the pipe. This watertight plug shall be fastened in the end of the water main in such a manner as to prevent it from floating or being otherwise displaced whenever construction operations are temporarily halted, such as at noon or at the end of the day's Work.
- C. Each section of pipe, when placed to grade and line, shall have firm bearing on the trench bedding throughout its length between bell holes.
- D. Cutting of pipe shall be done with approved tools and by approved methods suitable for the pipe material. Pipe cutting methods that produce a smooth, square-cut end without damage to the pipe and that minimize airborne particles, shall be employed.

Pipe cutting shall be performed using the recommendations of the manufacturer for the type of pipe materials being cut and according to the best trade practices.

- E. When cutting pipe or fittings, care shall be taken to prevent damage to linings and coatings. Damage to linings shall be cause for rejection of the complete Section. Damage to exterior coatings shall be corrected to original Specifications.
- F. Where pipe using a resilient gasket to affect the seal is cut, the cut pipe end shall be tapered at a 30-degree angle with the centerline of the pipe, and ground smooth, on the outside end to remove any sharp edges or burrs which might damage the gasket.
- G. Unless otherwise specified, 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 end of the adjacent pipe section, the pipe shoved into position and brought to true alignment and secured with sand tamped under and on both sides of the pipe except at bell holes. Adequate support shall be provided for all water main pipe.
- H. After the bottom of trench has been excavated the pipe bedding material will be installed in accordance with Section 31 2333, Trenching and Backfilling. The pipe shall then be installed strictly in accordance with the manufacturer's recommendations. After the pipe is laid, the bedding shall be continued above the pipe as specified in Section 31 2333, Trenching and Backfilling. Particular care shall be taken to assure filling and tamping all spaces under, around and above the top of the pipe.
- I. A continuous and uniform bedding as specified in Section 31 2333, Trenching and Backfilling, shall be provided in the trench for all buried pipe.
- J. Backfill shall be as indicated on the Plans and as specified in Section 31 2333, Trenching and Backfilling.
- K. Install bolts, studs, and nuts of the type specified per the manufacturer's installation and torquing requirements. All steel bolts, studs, and nuts shall be painted with bituminous paint after installation.

3.04 Installation of Ductile Iron Pipe

- A. Push-on-joints shall be made by means of a compression type push-on resilient gasket. Gasket shall be prelubricated before installation using a lubricant recommended by the pipe manufacturer. The seated joint shall be identified by the visible mark on the spigot of the installed pipe section.
- B. Mechanical joints shall be made with bolts, molded resilient gasket and cast iron follower gland. Nuts shall be screwed up finger tight before using a wrench. The gland and rubber gasket shall be brought up evenly at all points around the bell flange and then torqued per the manufacturer's recommendations.
- C. Exposed portions of bolts shall be covered with mastic.
- D. Flexible joint pipe shall be assembled, handled and installed in accordance with the printed recommendations which accompanies the pipe and is provided by the manufacturer of the piping materials being installed. Methods of handling and installation shall be acceptable to ENGINEER.

3.05 Installation of Concrete Pipe

- A. Pipe and fittings shall be jointed by means of a resilient gasket and steel spigot ring. Resilient gasket shall be lubricated and installed to form a watertight joint between the bell and spigot of the pipe.
- B. Pipe shall be laid in accordance with the accepted tabulated laying schedule and the Plans. Short lengths of pipe (ten (10) feet or less) (3 m) specified under Article 1.06 of this Section shall be installed and evenly distributed along the line of the Work, if required.
- C. Bell of the pipe in place shall be cleaned and properly lubricated and pipe section installed. After the spigot is well entered into the bell and the gasket is fully compressed and brought to final shape, prior to driving the pipe home, check each gasket for proper position around the full circumference of the joint and complete installation.
- D. Provide cloth bands wired around each joint outside diameter and grout with Portland cement mortar grout. Completely fill the annular recess between the adjoining bell and spigot pipe ends. Annular spaces between pipe ends on the inside of joints of pipe 24 inches (600 mm) or more in diameter shall be filled with Portland cement mortar grout.

3.06 Installation of Polyvinyl Chloride Pipe

- A. Polyvinyl chloride pipe shall be laid with gasketed joints in complete accordance with AWWA C605 and the pipe manufacturers published instructions. Joints shall be sufficiently lubricated using the pipe manufacturers recommended lubricant.
- B. Gaskets for pipe joints shall be inserted with the painted edge facing the end of the bell. Each length of pipe shall be pushed home individually. Pipe shall be positioned so that the reference mark on the spigot end is in line with the bell end.
- C. Tracer wire is to be installed along with PVC water mains. Tracer wire is to be continuous from end to end and terminate at each structure in such a way and with a sufficient length of wire to allow for easy connection to utility tracing equipment. Wire shall be continuity tested after installation. Any wire which fails the continuity test shall be replaced.

3.07 Installation of Restrained Joints

- A. Restrained joints shall be provided where indicated on the plans. Joints shall be assembled in strict accordance with manufacturer's directions. Joints shall be fully extended after assembly.

3.08 Fittings, Strapping, and Lugged Pipe

- A. Install all fittings to the lines, levels and locations indicated on the Plans. Fittings shall be provided with restraints as specified herein, as indicated on the Plans, or as required for a functional installation.
- B. Where indicated on the Plans or as determined by ENGINEER, bends in water main piping and piping runs subject to impact reaction shall be secured by means of metal strapping. Install all necessary bands, tie rods, nuts, and washers required. No metal strapping shall be used in direct contact with polyvinyl chloride pipe.
- C. Where lugged pipe and special fittings are indicated on the Plans, furnish and install all necessary tie rods, nuts, and washers.

3.09 Polyethylene Encasement

- A. Where called for on the plans, ductile iron water main, fittings and hydrants shall be encased in a polyethylene film tube.
 - 1. Service taps, bends, tees and other connections shall be made to polyethylene encased pipe in accordance with section 4.4.6 of AWWA C105.
- B. Polyethylene film tube shall be installed in accordance with ANSI/AWWA C105/A21.5, Method A.
 - 1. Method A consists of cutting the polyethylene tube two feet longer than the pipe to provide an overlap at the joints.
- C. The cost of the polyethylene encasement shall be incidental to the water main.

3.10 Valves

- A. Valves shall be installed to the grade, lines, levels and locations indicated on the Plans.
- B. Valve connections shall be as specified for the piping materials used. Valves shall be set with the stem plumb on permanent, firm foundations as indicated on the Plans.
- C. Where required, valves shall be supported with special supports as indicated on the Plans and as approved by ENGINEER. Valves shall be installed so as not to receive support from the connecting pipe. In no case shall valve installation be used to bring misaligned pipe into alignment.

3.11 Water Main Structures

- A. Construct water main valve wells and structures to the grades, lines and levels indicated on the Plans and as specified. Structures shall be complete with concrete bases, reinforcing, frames, covers, adjustment rings, etc. as shown and as required for a complete installation. Construction of water main structures shall conform to the type of construction and dimensions indicated on the Plans and as described below.
- B. Block Structures:
 - 1. Construct concrete block structures in the locations and according to the details on the Plans. The first course of concrete blocks shall be placed on the prepared base or footings in a full bed of mortar.
 - 2. Mortar joints shall be full and close in courses. Courses shall be level throughout. Stagger joints in adjoining courses by one-half the length of the block as nearly as practicable.
 - 3. Joints shall be uniform in thickness throughout the structures. Strike joints and properly point to provide true, smooth surfaces.
- C. Precast Concrete Structures:
 - 1. Construct precast concrete structures as detailed on the Plans. Provide mortar joints struck smooth. Provide 2 to 4 courses of 8-inch (200 mm) brick at top of structure for future adjustment.

- D. Cement mortar plaster coat shall be applied to the exterior surfaces of all brick or block gate wells and other water main structures indicated on the Plans. Plaster coat shall be 1/2 inch (10 mm) thick and shall be applied to the outer surfaces of the structures.
- E. Provide and install to the elevations shown cast iron covers, frames, adjusting rings, anchors, etc., indicated on the Plans and as required. Castings shall be set in a full bed of cement mortar 1/2 inch (10 mm) thick minimum. Mortar joints shall be struck smooth.
- F. Install steps for structures of types and in locations indicated on the Plans. Steps shall be installed on 16-inch (400 mm) centers minimum, unless shown otherwise on the plans.
- G. Pipe placed in structures for inlet or outlet connections shall extend through the walls and beyond the outside wall surfaces a sufficient distance to allow for complete connections. Openings between pipes and walls shall be sealed with a full bed of cement mortar. Pipe shall be supported by concrete supports.

3.12 Valve Boxes

- A. Install valve boxes to the grade, lines, levels and locations indicated on the Plans. Valve boxes shall not transmit shock or stress to the valve and shall be set plumb with covers centered over operating nuts and flush with the indicated surface elevations. Valve boxes that shift or fill during backfilling shall be uncovered and reset.

3.13 Hydrants

- A. Hydrants shall be installed plumb to the lines, levels, grades and locations indicated on the Plans. Hydrants shall be set to the established grade, shall have their nozzles parallel to or at right angles to and facing the grade or curb.
- B. Where necessary to adjust for proper hydrant location, CONTRACTOR shall install additional pipe between the water main and road box. Hydrant extensions shall be installed to adjust hydrant to proper grade.
- C. CONTRACTOR shall plumb hydrants at the time they are set with a plumb line or other means acceptable to ENGINEER.
- D. Upon substantial completion of cleanup, CONTRACTOR shall recheck hydrants for plumb and grade and shall make adjustments as necessary at this time.
- E. The Work of constructing fire hydrants shall not be considered complete until these final adjustments for plumb and grade have been made.

3.14 Fire Hydrant Approaches

- A. Fire hydrant approaches shall consist of culvert pipe with end protection and a gravel approach.
- B. Culvert pipe shall be of the size and type shown on the Plans. Pipe shall be installed to the existing or proposed grade of the drain or ditch with pipe bedding and backfill from a point 4 inches (100 mm) below the pipe to a point 12 inches (300 mm) above the top of the pipe, consisting of bank run sand meeting the requirements of MDOT Class II granular material and compacted to 95% of maximum unit weight. Each end of the culvert pipe shall be protected against erosion, as shown on the Plans.

- C. Gravel approach shall extend from the edge of the traveled portion of the road to the fire hydrant and shall be a minimum of 10 feet (3 m) wide. Approach shall consist of a minimum of 6 inches (150 mm) of compacted 22A or 23A aggregate, with calcium chloride applied at a rate of 6 pounds per Ton (3 kg per metric ton) of aggregate.

3.15 Air Release Assembly

- A. Provide materials and construct air release assemblies where indicated on the Plans. Install valves, fittings, caps, plugs and piping as required. Fittings and joint materials used for air release assemblies shall be as specified herein for the water main piping materials used.

3.16 Blow-off Assembly

- A. Provide materials and construct blow-off assemblies where indicated on the Plans.
- B. Blow-off assemblies and pipe shall be installed to the lines, levels and elevations shown. Install valves, fittings, reducers, piping, plugs, joints, etc., as detailed.
- C. Blow-off assemblies shall be installed on stable, undisturbed earth materials with changes in directions and returns provided with bedding and restraints as indicated on the Plans, as specified herein and as required for a complete installation.
- D. Blow-off assemblies shall include valve boxes as detailed.

3.17 Tapping Valve Assembly

- A. Install tapping valve assemblies of sizes and to the lines, elevations, locations and details indicated on the Plans.
- B. Tapping sleeve shall be assembled around the main, and the tapping performed in strict accordance with the manufacturer's recommendations.
- C. Tapping shall be accomplished without interruption of service.

3.18 Anchors, Encasements, and Restraints

- A. Plugs, tees, sleeves, bends, caps, straps and lug piping shall be provided with suitable anchors, encasements and restraints as indicated on the Plans. Anchoring, encasement and restraint methods shall be as detailed. Bearings shall be as shown.
- B. Anchors, encasements and restraints shall rest on firm, stable, compacted subgrade and shall be provided for all standard and special fittings.

3.19 Water Service Lines

- A. When so indicated in the Proposal, or on the Plans, CONTRACTOR shall provide water service lines in accordance with this Section. Otherwise, water service lines are not required.
- B. Water service lines shall be installed after the water main has been successfully tested and put into service, including the installation of fire hydrants.
- C. Service lines shall be of the type indicated on the Plans, and shall be 3/4 inch (20mm) diameter unless otherwise indicated on the Plans or Proposal.

- D. Water service lines shall be provided for all lots or parcels at the locations indicated on the Plans, within these Contract Documents or as designated by ENGINEER. Service lines shall extend from the water main to within 1-foot (300 mm) of the limits of a right-of-way or easement at a minimum 5-foot (1.5 m) depth terminating with a curb stop and curb box as specified herein.
- E. Water service lines under concrete or asphalt pavements shall be installed by boring or tunneling, unless otherwise indicated on the Plans or approved by ENGINEER.
- F. Backfilling of open cut construction for water services shall be in accordance with Section 31 2333, Trenching and Backfilling, after the service line, including curb stop, has been laid and approved by ENGINEER. Prior to backfilling the service line CONTRACTOR shall request an inspection by ENGINEER and obtain approval of the service line.
- G. Alternative methods such as hydraulic jacking; air jetting; piston mole; etc, may be used to install water service lines if approved by ENGINEER.
 - 1. Proposed method must be approved by the governmental agency having jurisdiction over the work area and CONTRACTOR must demonstrate that, in the opinion of ENGINEER, the method is suitable for local soil and ground conditions.
 - 2. To be found suitable for local conditions, the method must be demonstrated to perform within acceptable horizontal and vertical accuracy limits, must not compress soil beyond acceptable limits, and must not leave voids in the soil. Water jetting shall not be permitted.
 - 3. Final installation of the service pipe must be in accordance with manufacturer's recommendations and no joints or fittings shall be allowed under roadway surfaces.
- H. Existing water mains shall be kept in service until all water services have been connected to the new mains. CONTRACTOR shall repair all water services damaged during the installation of the new water mains. Only after the new mains have been accepted and put into service, will service connections be made to the new mains.
- I. Reconnection of Water Services:
 - 1. Connection of existing service lines to the new mains shall be made within the street rights-of-way or within the easements, utilizing the existing curb stops.
 - 2. Existing lead water service lines shall be abandoned and new water service lines installed from the new water main to the existing curb stops.
- J. Backfill, method of construction under pavements, and new water service lines shall be as specified in this Section.

3.20 Corporation Stops

- A. Corporation stops shall be located on water main piping where indicated on the Plans, or as determined by ENGINEER.
- B. Corporation stops on PVC water mains shall be made with service saddles.
- C. Install a minimum of two (2) corporation stops in each valve well.

- D. One-inch (25 mm) tapping outlets shall be installed at approximately 20-foot (6 m) intervals along the entire length of the concrete water main. Tapping outlets shall be constructed as detailed on the plans and shall be positioned 45 degrees off vertical. Location of the tapping outlets shall be marked by means of No. 4 (No. 13M) reinforcing rod. The rod shall be placed in a vertical position immediately adjacent to, but not touching, the water main and the top, 6 inches (150 mm) below finished grade.

3.21 Service Saddles

- A. Where service saddles are to be installed, the entire circumference of the main shall be free of loose material. Installation of the saddle and tapping of the main shall be in accordance with manufacturer's recommendations.

3.22 Curb Stops

- A. Install curb stops of the types and sizes indicated on the Plans. Curb stops shall include furnishing and installing a curb box.

3.23 Abandoning Water Main

- A. Install cap with a minimum 2-inch (50 mm) diameter threaded opening at one end of water main to be abandoned and solid cap at opposite end.
- B. Install a minimum 2-inch (50 mm) diameter stand pipe no farther than 1-foot (0.3 m) from the end with the solid cap in the top of the water main to be abandoned. The stand pipe should be installed such that it can be removed after use and the hole sealed.
- C. Install a minimum 2-inch (50 mm) diameter drain pipe in threaded opening. Pipe shall be installed in the opposite end of the water main from the stand pipe. Pipe should bend up to a 90 degree angle with the end of the pipe being a minimum of 6 inches (150 mm) above the top of the water main.
- D. Using the stand pipe, fill the water main to be abandoned with flowable fill material. Material shall be placed in the water main until free water flows from the drain pipe at the opposite end. Continue filling water main until the material released at the drain pipe is representative of the flowable fill being introduced at the fill end of the water main, at which time the drain pipe will be sealed with a threaded cap and the filling terminated.
- E. Remove the stand pipe and cap the filling hole.

3.24 Relocate Water Main

- A. Relocate water main shall consist of removing and relaying an existing water main to go under or over a proposed utility. Existing pipe shall be removed and disposed of. Bends and vertical anchors shall be installed as shown on the plans. Verticals anchors and thrust blocks shall be sufficient to resist thrust forces.

3.25 Abandon Existing Gate Valve and Well

- A. Gate valve and well, and other water main structures on the existing water main, shall be abandoned and the structures shall be abandoned in accordance with the following:
 - 1. Abandonment of existing structures shall consist of removing and salvaging the existing frame and cover.
 - 2. The valve shall be opened.

3. Masonry shall be broken down to an elevation at least 3-feet (1 m) below the subgrade.
4. Abandoned structure shall be backfilled with flowable fill to 1-foot (300 mm) above the pipes and the remainder of the structure with sand-cement mixture at a 10 to 1 ratio to subgrade elevation or to 1-foot (300 mm) below finished grade.

3.26 Remove Gate Valve and Well

- A. Gate valve and well, and other water main structures on the existing water main, shall be removed in accordance with the following:
 1. Removal of existing structures shall consist of removing and salvaging the existing frame and cover, and valve.
 2. Ends of the existing water main shall be plugged and braced.
 3. Complete structure shall be removed entirely and disposed of.
 4. Excavation shall be backfilled with sand and compacted to 95 percent of its maximum unit weight.

3.27 Remove Existing Fire Hydrants

- A. Fire hydrants on the existing water main shall be removed by excavating and removing the existing fire hydrant, gate valve, and valve box.
 1. Existing hydrant lead shall be capped and blocked.
 2. Fire hydrant, valve, and box shall be salvaged and delivered to a location as designated by OWNER.
 3. Excavation shall be backfilled with sand and compacted to 95 percent of its maximum unit weight.

3.28 Relocation of Fire Hydrants

- A. Relocation of hydrants shall include the provision of new hydrant shoes, frost jacket and restraints.
- B. Provide new materials required for hydrant relocation.
- C. Reinstall hydrants at the new locations to the lines and levels shown.
- D. Make joint connections to new or existing water mains, joints, couplings, etc., as shown and as required.
- E. Provide anchorage and restraint for a complete installation.

3.29 Hydrostatic Testing

- A. General:
 1. After the pipe has been laid and backfilled, the pipe shall be hydrostatically tested for leakage. CONTRACTOR shall furnish the pump, pipe connection, hydrants, valves and any other necessary apparatus including gages and meters and all personnel necessary for conducting the test.

Before applying the test pressure, all air shall be expelled from the pipe. If necessary to accomplish this, taps shall be made at points of higher elevation and afterwards plugged.

2. Test sections shall not exceed 1 mile (1.6 km) and in the event more than 1 mile (1.6 km) of water main is tested, the permissible leakage will remain at the amount determined for 1 mile (1.6 km) of pipe.
3. Hydrostatic testing shall conform to AWWA C600.

B. Testing Ductile Iron Water Main:

1. The test shall be made at a pressure of 150 pounds per square inch (1 MPa) gage minimum. Full pressure shall be held for at least 2 hours.
2. Any faulty pipe fitting, gate valves or other accessories which permit leaks during testing shall be replaced by CONTRACTOR with sound material and the test shall be repeated until specified requirements are met.
3. Maximum permissible leakage measured by water meter from the section of main tested under pressure, shall not exceed a rate of 10 U.S. gallons, per inch diameter of main, per mile of pipe, in 24 hours for each section tested.
 - a. No pipe installation will be accepted if the leakage is greater than the allowable leakage calculated in accordance with the following formula:

$$L = \frac{S * D * (P)^{\frac{1}{2}}}{148,000}$$

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 leakage test, in pounds per square inch (gauge)

Allowable Leakage per 1000 Feet of Ductile Iron Water Main Tested

Average Pressure (psi)	Nominal Pipe Diameter in Inches											
	3	4	6	8	10	12	14	16	18	20	24	30
175	0.27	0.36	0.54	0.72	0.89	1.07	1.25	1.43	1.61	1.79	2.15	2.68
150	0.25	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.49	1.66	1.99	2.48
125	0.23	0.30	0.45	0.60	0.76	0.91	1.06	1.21	1.36	1.51	1.81	2.27

C. Testing PVC Water Main:

1. The test shall be made at a pressure of 150 pounds per square inch (1 MPa) gage minimum. Full pressure shall be held for at least two (2) hours.
2. Any faulty pipe fitting, gate valves or other accessories which permit leaks during testing shall be replaced by CONTRACTOR with sound material and the test shall be repeated until specified requirements are met.
3. The maximum permissible leakage measured by water meter from the section of main tested under pressure, shall not exceed a rate of 10 U.S. gallons, per inch diameter of main, per mile of pipe, in 24 hours for each section tested.

- a. No pipe installation will be accepted if the leakage is greater than the allowable leakage calculated in accordance with the following formula:

$$L = \frac{S * D * (P)^{1/2}}{148,000}$$

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 leakage test, in pounds per square inch (gauge)

Allowable Leakage per 1000 Feet of PVC Water Main Tested

Average Pressure (psi)	Nominal Pipe Diameter in Inches											
	3	4	6	8	10	12	14	16	18	20	24	30
175	0.27	0.36	0.54	0.72	0.89	1.07	1.25	1.43	1.61	1.79	2.15	2.68
150	0.25	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.49	1.66	1.99	2.48
125	0.23	0.30	0.45	0.60	0.76	0.91	1.06	1.21	1.36	1.51	1.81	2.27

3.30 Flushing

- A. After completion of water main installation, flush the new mains, valves, hydrants and appurtenances completely and as acceptable to ENGINEER.
- B. Heavily chlorinated water discharged from a disinfected system shall be controlled adequately to protect any surface water resource or adjacent property from potential environmental damage, or from creation of a hazard to traffic.
- C. Remove and dispose of all temporary installations at completion of the flushing operation.
- D. After flushing, and prior to final approval of the system, CONTRACTOR shall pump down all fire hydrants and verify that the hydrant valve is properly seated to prevent the hydrant standpipe from filling with water.

3.31 Disinfection

- A. General:
 1. Potable water pipelines, except those appurtenant to hydraulic structures, shall be disinfected in accordance with the requirements of ANSI/AWWA C651 using the Continuous-Feed Method as modified herein.
- B. Chlorination:
 1. The liquid mixture shall be applied by means of a solution-feed chlorinating device.
 2. CONTRACTOR shall install corporation stop and feed chlorine solution through the corporation stop at the beginning of the main or valved section.
 3. A slow flow of water shall be let into the main approximately at the point of injection of the chlorine solution, at a rate such that the chlorine dosage of the entering water shall be at least 50 mg/l; free chlorine concentration at initial chlorination shall be a minimum of 25 mg/l.

4. An open discharge shall be maintained at the far end of the section of main being chlorinated, and the introduction of chlorine solution and water shall continue until the water discharging at the far end shall carry the required dosage of chlorine.
 5. As the main is filled with chlorinated water, each outlet from the main shall be opened and sufficient water drawn off to assure that the full dosage of chlorine reaches each outlet.
 6. Back pressure causing a reversal of flow in the main being chlorinated shall be prevented, and pressure in the main shall be held down to a point which will make it impossible for chlorinated water to be forced into other sections of the main or water system.
 7. If the chlorine residual shall be less than 10 mg/l at the end of 24 hours, further application of chlorine shall be made and the retention period repeated until the required 10 mg/l residual is obtained.
- C. Repetition of Test:
1. The disinfection testing procedure shall be repeated if the initial tests fail to produce satisfactory results.
 2. Two consecutive satisfactory test results shall be required after any unsatisfactory test.
 3. The tablet method shall not be used for repeated disinfection.

3.32 Water for Cleaning, Testing and Disinfection

- A. Water for cleaning, testing and disinfection shall be obtained from a potable water supply. CONTRACTOR shall provide all water required at his own expense and shall make all necessary arrangements with the authority which controls the source of water system and shall be governed in his use of water by all rules and regulations imposed thereon by said authority.
- B. CONTRACTOR shall provide and remove temporary connections between the source water system and the mains constructed under this contract. All temporary connections shall meet the approval of the ENGINEER, the authority controlling the source water system, and Public Health authorities having jurisdiction.
- C. CONTRACTOR shall be responsible for the safe disposal of chlorinated water flushed from water mains following disinfection procedures. CONTRACTOR shall be responsible for disposing of disinfecting solution in a manner in accordance one of the following approved manners:
1. Discharge chlorinated water directly into a nearby sanitary sewer provided that the water will receive subsequent treatment and disposal by a properly permitted wastewater treatment plant.
 2. Dechlorination may be required by the wastewater treatment plant prior to receiving the discharge water.
 - a. CONTRACTOR must obtain written permission from the wastewater treatment plant prior to discharge and shall verify whether or not dechlorination is necessary prior to disposal.

- b. CONTRACTOR shall submit a copy of the written authorization from the wastewater treatment plant to ENGINEER and the OWNER prior to disposal.
- 3. Discharge chlorinated water to a surface water body, either directly or indirectly (i.e., through a storm sewer).
 - a. Prior to discharging, CONTRACTOR shall obtain a National Pollutant Discharge Elimination System (NPDES) general discharge permit, and shall comply with the associated monitoring and reporting requirements of the issuing agency, including dechlorination.
 - b. CONTRACTOR shall submit a copy of the NPDES permit to the ENGINEER and the OWNER prior to disposal.
- 4. Discharge chlorinated water to the ground under Act 451 of the Part 31 Rules.
 - a. Prior to discharging, CONTRACTOR shall dechlorinate the water to below 4 milligrams per liter (mg/L).
 - b. Following dechlorination, CONTRACTOR shall discharge to an area large enough, and with suitable soils, to prevent site runoff.
- 5. CONTRACTOR must obtain written permission from the landowner where the discharge is to take place and written verification that dechlorination is or is not necessary prior to disposal and that a value of less than 4 mg/L of chlorine is present within the water.
 - a. CONTRACTOR shall submit a written copy both the ENGINEER and the OWNER prior to disposal.

3.33 Bacteriological Analysis

- A. General:
 - 1. Prior to placing a water main in service, not less than two (2) consecutive water samples taken 24 hours apart for bacteriological analysis shall be collected and each analysis shall show results meeting state and local drinking water standards.
 - 2. Samples will be taken at locations indicated in ANSI/AWWA C651 and will be tested for coliform organisms and heterotrophic plate count according to the latest edition of the *Standard Methods for the Examination of Water and Wastewater*.
 - 3. CONTRACTOR shall collect water samples and cause analyses to be made at his own expense. Samples shall be collected in accordance with AWWA C651. Testing laboratory and sample collection shall meet the approval of public agency having jurisdiction.
 - 4. If disinfection fails to produce satisfactory bacteriological counts, the pipe shall be refushed and will be resampled and retested.
 - a. If counts from analysis of the second samples exceed the criteria in Standard methods, the pipe shall be re-disinfected and will be resampled and retested until satisfactory results are obtained.

- b. CONTRACTOR shall be responsible for all repeat bacteriological testing costs.
- B. Sampling:
 - 1. Per AWWA Standards, no sampling stations shall be at a distance greater than 1,200 feet.
 - 2. Mains shall be flushed at an adequate velocity prior to sampling to remove any debris remaining in the pipe.
 - 3. Sampling must be accomplished by a certified treatment/distribution operator or an employee of a certified laboratory. This certification will be evidenced in the approved plan.
 - 4. At OWNER's discretion, the source water will be sampled or the nearest water quality sample station's most recent results will be used to determine the baseline water quality.
 - 5. Samples must be collected from extreme ends, all branches of the new main and at a minimum 300-foot interval. The sample points will also be part of the approved plan.
 - 6. The temperature and total chlorine residual will be measured with a field test kit and recorded by the sampler on the "chain of custody" form.
 - 7. After another 24-hour period, a second set of samples will be collected from the same sample points.
 - 8. Both sets will be analyzed for total and fecal coliform presence/absence and heterotrophic plate count.
 - 9. OWNER reserves the right to sample for bacteria at its own discretion with notice.
- C. Laboratory Report:
 - 1. General:
 - a. Lab results will be reported on a chain of custody, lab work sheet, or summary letter imprinted with the laboratory's name, address, and phone number.
 - (1) The report will include the field tests and laboratory analysis.
 - (2) The report will be signed by the laboratory director.
 - b. It will be OWNER's right, and responsibility to reject the report if any data is missing or suspect due to conflicting indications.

3.34 Cleaning (Pigging)

- A. When required in the plans or specifications, water main shall be mechanically cleaned. Cleaning shall be with a metal bodied, mandrel type solid plug (pig) with scrapers. The pig shall be pulled or otherwise propelled through the entire line prior to testing or connecting to any existing water main.

End of Section

Section 33 3000

Sanitary Utility Sewerage Piping

Part 1 General

1.01 Scope of Work

- A. This Section includes sanitary sewer Work indicated on the Plans complete with pipe, joints, structures, pipe bedding, installation, television inspection, and testing.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200: Unit Prices
- B. Section 04 0511: Mortaring and Grouting
- C. Section 31 2316: Structural Excavation and Backfill:
- D. Section 31 2319: Dewatering
- E. Section 31 2333: Trenching and Backfilling
- F. Section 31 7000: Tunneling and Mining

1.03 Requirements of Regulatory Agencies

- A. Testing shall conform to the applicable requirements of State and local authorities having jurisdiction, and shall include such tests as: deflection, air, exfiltration and infiltration.

1.04 Reference Standards

- A. Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. ANSI - American National Standard Institute
 - 2. ASTM - American Society for Testing and Materials
 - 3. MDOT - Michigan Department of Transportation, Standard Specifications for Construction, latest edition
 - 4. NCPI - National Clay Pipe Institute

1.05 Source Quality Control

- A. Laboratory test not less than 1 percent, with a minimum of 3 pieces, each size, material and class of gravity pipe required in the Work.

1.06 Tolerances

- A. The actual grade of the invert of the sewer shall not deviate from plan grade by more than 0.1 feet/100 feet (0.03 m/30 m), and not more than 0.2 ft. (60 mm) in total for a sewer run from manhole to manhole.
- B. Alignment of sewer shall be within 0.2 feet/100 feet (0.06 m/30 m) and within 0.5 feet (150 mm) in total for a sewer run from manhole to manhole.

1.07 Submittals

- A. Submit independent grade checks in accordance with Article 3.06 of this section.

- B. Submit manufacturer's data for pipe bulkheading devices in accordance with Article 3.13 of this Section.
- C. A complete field report of the location of wyes, risers and building leads shall be submitted to ENGINEER at the end of each sewer section of the Project or on the last day of each week, whichever occurs first.
 - 1. Complete field report shall include witnessing by CONTRACTOR of the ends of building leads placed. Witnessing shall consist of recording 3 horizontal distances to the nearest foot (0.3 m) with the lines of measurement at minimum angles of 45 degrees with respect to one another. Witnessing shall also include recording of the depth to nearest 1/2 foot (0.1 m) from the invert at the end of the lead to the finish ground above the end of the lead.
 - 2. No payment will be made for un-witnessed installation or for improperly witnessed installations.
- D. As part of the television inspection, a wye location report shall be submitted to ENGINEER. The report shall contain the precise location of each wye, notes, photographs, and other pertinent information.
- E. Submit 2 copies of the laboratory test reports required per Article 1.05 of this Section to ENGINEER.
- F. Shop Drawings shall be provided of all manhole tees.

1.08 Storage of Materials

- A. Piping material shall not be stacked higher than 4 feet (1.2 m). Suitable racks, chairs, and other supports shall be provided to protect preformed pipe mating surfaces from damage. Store bottom tiers off the ground, alternate tiers and chock tier ends.
- B. Joint and sealing materials used in the sanitary sewer system shall be protected from sunlight and stored in cool and clean place until ready for installation.

1.09 Handling of Material

- A. Load and unload piping using suitably approved hoists, skids, etc. Piping shall not be dropped, bumped or allowed to impact against itself. Damaged piping not be used by CONTRACTOR.
- B. Lifting devices shall be suited to the Work and shall protect surfaces from damage.

Part 2 Products

2.01 General

- A. It is the intent of the Articles in Part 2 of this specification section to specify in detail the various types of sewer pipe, joints, manholes, etc. which have been indicated throughout the Plans and specifications. These Articles shall not be construed as allowing any alternate type of material to that which is indicated on the Plans or elsewhere in the specifications.

2.02 Clay Pipe Systems

- A. Pipe shall conform to ASTM C700, extra strength vitrified clay pipe.
- B. Joints for clay pipe shall meet the requirements of ASTM C425. Joints for house leads shall be limited to approved compression type joints with the sealing element bonded to the bearing surfaces.
- C. Only lubricant as supplied by the pipe manufacturer shall be used on the bell and spigot in making up joints and the joints shall be coupled in accordance with the pipe manufacturer's requirements.
- D. Wyes and tees shall be manufactured to the same standards as the pipe. Wye and tee fittings shall be furnished with the spurs securely fastened by the manufacturer to the barrel of the pipe. There shall be no projection on the inner surface of the pipe.

2.03 Precast Concrete Pipe Systems

- A. Non-reinforced Concrete Pipe:
 - 1. Pipe shall conform to ASTM C14 Class III nonreinforced concrete sewer pipe.
 - 2. See Article 2.03.C for requirements for joints.
- B. Reinforced Precast Concrete Pipe System:
 - 1. Pipe shall be ASTM C76. 10-inch (250 mm) diameter pipe shall have steel and concrete as specified for 12-inch (300 mm) diameter pipe, ASTM C76, Class II through Class V, Wall B or Wall C, circular reinforced.
 - 2. Twelve (12) -inch through 30-inch diameter (300 mm through 750 mm) pipes shall be ASTM C76, Class II through V, Wall B or Wall C, circular reinforced.
 - 3. Thirty-six (36) -inch through 108-inch (900 mm through 2700 mm) diameter pipes shall be ASTM C76, Class I through V, Wall B or Wall C, circular or elliptical reinforced.
 - 4. When elliptical reinforcement is used, the following method of indexing the steel and the pipe barrel shall be used:
 - 5. A dummy lift pin form shall be set in the outer pipe wall form projecting into the pipe wall a minimum 1-3/4 inches (45 mm) and a maximum of 2-1/4 inches (55 mm). An additional spacer chair shall be welded to the elliptical steel cage at the proper location so as to engage the dummy lift pin form during the pipe casting operation.
 - 6. It is the intent of the spacer chair and dummy lift pin arrangement to provide a means of assuring the final position of the elliptical steel cage within the barrel of the pipe and, for providing a means of indexing the pipe in the field to assure proper placement of the pipe.
 - 7. Prior to shipment of the pipe, they shall be striped along the inside top with a minimum 1-inch (25 mm) wide indelible marker so that final inspection of the pipe orientation can be made following completion of the installation.

8. For pipe 114 inches (2850 mm) or larger in diameter, the design information in accordance with Section 6 of ASTM C76, shall be submitted to ENGINEER for approval, prior to fabrication. The design of pipes shall meet the D-load requirements for the class of pipe indicated on the Plans.

C. Joints for Concrete Pipe:

1. Premium joints for concrete pipe shall be ASTM C443 limited as follows: Section 6.1 of C443, "Physical Requirements for Gaskets," shall be replaced with Section 6.9 of C361, "Rubber Gaskets." Also, Section 5 of C443 shall be limited to a modified grooved tongue to receive an "O" ring rubber gasket.
2. For concrete pipe sizes 10-inch to 24-inch (250 mm to 600 mm), the modified grooved tongue and bell ends of the pipe shall be made smooth and shall not have over a 3-1/2-degree slope formed to fit the rubber gasket to tolerances as determined by the manufacturer. Pipe tongue shall not be out of round by more than $\pm 1/16$ inch (1 mm).
3. For pipe sizes 27 inches to 108 inches (675 mm to 2700 mm), the modified groove and bell ends of the pipe shall be smooth and shall not have over a 2-degree slope, formed to fit the rubber gasket to tolerances as determined by the manufacturer.
4. For pipe sizes 36 inches (900 mm) and larger, the tongue shall be reinforced with an amount of circular steel equivalent in area to the inner steel cage specified for the pipe barrel and the bell shall be reinforced with an amount of circular steel equivalent in area to the outer steel cage specified for the pipe barrel.
5. For pipe sizes under 36 inches (900 mm) in diameter, including C14-XM5 extra strength, the bell or tongue shall be reinforced. Where the reinforcing steel for the tongue, barrel and bell is not continuous, the steel shall be lapped a minimum of two (2) inches (50 mm).
6. Only lubricant, as supplied by the pipe manufacturer, shall be used on the groove and on the tongue in making up joints, and the joints shall be coupled in accordance with the pipe manufacturer's requirements.
7. Joints in concrete pipe 36 inches (900 mm) in diameter and larger shall have the inside annular space filled with cement mortar and troweled flush. Mortar shall consist of 1-part Portland Cement and two (2) parts of plaster sand. Mortar for inside joints shall be mixed with only enough water for dry packing.

D. Wyes and Tees:

1. Wyes and tees shall be manufactured to the same standards as the pipe. Spurs shall be of the same size and type as the house lead/riser pipe. Wye and tee fittings shall be furnished with the spurs securely fastened by the manufacturer to the barrel of the pipe. There shall be no projection on the inner surface of the pipe.

2.04 ABS Pipe

- A. Acrylonitrile-Butadiene-Styrene (ABS) Truss pipe shall be constructed in accordance with ASTM D2680. Pipe shall be of a double wall construction, braced with a truss-type structure with all three (3) formed in one (1) extrusion. Truss voids shall be filled with lightweight concrete to provide additional compressive strength and bracing.
- B. Solid wall pipe shall conform to ASTM D2751, SDR 23.5.
- C. Joints for Acrylonitrile-Butadiene-Styrene (ABS) composite pipe shall be ASTM D2680, Type S.C., a solvent-cemented joint in which pipe solvent cements into a coupling socket to form the joint closure. Installation of the solvent cement shall be in strict accord with the manufacturer's recommendations.
- D. Wyes and tees shall be manufactured to the same standard as the pipe. Spurs shall be of the same size and type as the house lead/riser pipe. Wye and tee fittings shall be furnished with the spurs securely fastened by the manufacturer to the barrel of the pipe. There shall be no projection on the inner surface of the pipe.

2.05 PVC Truss Pipe

- A. Polyvinyl Chloride (PVC) truss pipe shall be ASTM D2680. The pipe shall be of a double wall construction, braced with a truss-type structure with all three (3) formed in one (1) extrusion. The truss voids are filled with lightweight concrete to provide additional compressive strength and bracing.
- B. Joints for Polyvinyl Chloride (PVC) pipe shall be elastomeric gasketed conforming to ASTM D3212, push on type joint.
- C. Wyes or tees shall be a molded wye or tee fitting per ASTM D2680, with gasketed joints on each end suitable for directly inserting in the mainline pipe. Wye and tee fittings shall be furnished with the spurs securely fastened by the manufacturer to the barrel of the pipe. There shall be no projection on the inner surface of the pipe. Branch connection fitting shall be a gasketed joint suitable for the house lead pipe specified. Saddle connections are not allowed.

2.06 PVC Solid Wall Pipe

- A. PVC Solid Wall Pipe in sizes 6-inch through 15-inch (150 mm through 375 mm) shall be ASTM D3034, SDR 35, and in sizes 18-inch through 27-inch (450 mm through 675 mm) shall be ASTM F679 SDR35, polyvinyl chloride pipe (PVC).
- B. Joints for polyvinyl chloride pipe (PVC) shall be ASTM D3212, push-on type. A joint in which an elastomeric ring gasket is compressed in the annular space between a bell end or socket and a spigot end of pipe.
- C. Wyes or tees shall be a molded wye or tee fitting per ASTM D2680, with gasketed joints on each end suitable for directly inserting in the mainline pipe. Wye and tee fittings shall be furnished with the spurs securely fastened by the manufacturer to the barrel of the pipe. There shall be no projection on the inner surface of the pipe. Branch connection fitting shall be a gasketed joint suitable for the house lead pipe specified. Saddle connections are not allowed.

2.07 Dual Wall Corrugated PVC Pipe – Smooth Interior

- A. Pipe shall be a single extrusion of PVC with a smooth interior and corrugated outer walls. Corrugated outer profile shall be annular and seamless.
- B. Pipe and fittings shall be in accordance with ASTM F949. Joints shall be bell and spigot type with an elastomeric gasket meeting the requirements of ASTM F477 and be suitable for sanitary sewer service and the testing requirements of this section.
- C. Wyes or tees shall be a molded wye or tee fitting per ASTM F949, with gasketed joints on each end suitable for directly inserting in the mainline pipe. Branch connection fitting shall be a gasketed joint suitable for the house lead pipe specified. Saddle connections are not allowed.
- D. Connections to manholes that utilize a rubber boot (Kor-N-Seal) shall be accomplished by sealing the rubber boot to a rubber gasket installed on the outside of the pipe with the stainless-steel band and clamp assemblies on the outside of the rubber boot. For sizes 21-inch and larger use two stainless band assemblies (with two screw clamp assemblies per band assembly) on the outside of the rubber boot, with the screw clamps staggered around the pipe so that the take-up pressure is equalized.
- E. Connections to manholes with an A-Lok type connection shall use a manhole sleeve designed for connection to an A-Lok assembly with the recommended A-Lok ring number.
- F. Acceptable manufacturers of Dual wall corrugated PVC pipe include Contech A2000, Uponor ETI Ultra-Corr or ENGINEER approved equal.

2.08 Structures

- A. General:
 - 1. Material for sanitary sewer structures shall conform to the requirements as indicated on the plans and as specified below. Precast concrete structures are required except when constructing a structure over an existing sewer may require limited use of concrete block or brick as approved by ENGINEER.
- B. Concrete Brick:
 - 1. Concrete brick shall be ASTM C55, Grade S-II, solid units of nominal 3-inch (75 mm) thickness.
- C. Concrete Block:
 - 1. Block shall conform to ASTM C139, Portland cement conforming to ASTM C150, Type II. Blocks shall be solid curved blocks with the inside and outside surfaces parallel and curved to the required radii. The blocks shall have a groove or other approved type of joint at the ends.
- D. Precast Concrete:
 - 1. Precast concrete manhole, flat top slabs, risers, cone, transition sections and bottom sections shall conform to ASTM C478, and shall be circular with circular reinforcement. For depths greater than 32-feet, manhole shall be designed for

the earth loading at the design depth of bury with a factor of safety of 1.5. Base slab shall be 8 inches (200 mm) thick for depths up to 25 feet (7.5 m) and 12 inches (300 mm) thick for depths greater than 25 feet (7.5 m).

2. Transition sections, reducers and flat top slabs shall be designed for the earth loading at the design depth of bury with a factor of safety of 1.5.
3. Precast doghouse sections shall be used for connections to existing sewer 15 inches (375 mm) and smaller on straight through runs for a depth up to 20 feet (6 m) and on right angle runs, with a maximum of four cutouts for depths up to 12 feet (3.5 m).
 - a. Openings in precast doghouse sections shall be cast in the pipe before curing and no breaking or chipping of sections will be allowed after the manhole section has cured.
 - b. The size of the opening shall be cast as indicated on the Plans.
4. Precast bottom sections shall be cast with the bottom end flat to provide bearing of the full wall thickness. Openings for sewer pipe shall be cast in the manhole and the bottom section by the manufacturer.
5. Six (6) -inch through 24-inch (150 mm through 600 mm) connections to manholes shall use a mechanically compressible flexible joint, as indicated on the Plans.
6. Twenty-seven (27) -inch (675 mm) and larger connections to manholes shall be grouted, as indicated on the Plans.
7. Riser sections of a manhole shall have modified grooved tongue joints with "O" ring gaskets or a tongue and groove joint with a Butyl Rubber based gasket type sealant meeting the requirements of AASHTO M-198 and having a nominal size of 1-inch (25 mm).
8. Eccentric cone sections of a manhole shall have modified grooved tongue joints with "O" ring gaskets and be provided with 4-stud inserts cast in the top. The top shall have a smooth finished surface.
9. Concrete grade rings shall have smooth finished top and bottom surfaces. Grade rings shall be provided with "O" ring gaskets.
10. Precast manhole tees will be allowed on straight through runs with no angle at the manhole and where stubs or openings in manhole are above the tee section.
11. Precast concrete manhole tee units shall conform to ASTM C76, Class IV and shall be circular with circular reinforcement. Precast tees must be a monolithic pour with wire cage inspection prior to concrete placement. Joints for tee shall be the same as the joints on the sanitary sewer.

E. Manhole Steps:

1. Cast iron manhole steps shall conform to ASTM A48, Class 30, gray iron with a minimum cross section dimension of 1-inch (25 mm) in any direction.

2. Steel reinforced plastic manhole steps shall be of suitably approved co-polymer polypropylene conforming to ASTM D4101, PP0344B33534Z02 with 1/2 inch (12 mm) minimum diameter deformed reinforcing bar conforming to ASTM A615, Grade 60 and shall be in accordance with ASTM C478.
 3. Manhole steps shall be of the types and sizes indicated on the Plans and shall comply with applicable Michigan Occupational Safety and Health Standards (MIOSHA).
- F. Manhole Frames and Covers:
1. Manhole frames and covers shall conform to ASTM A48, Class 30, gray iron and shall be of the types and sizes as indicated on the Plans. Castings shall be neatly made and free from cracks, cold sheets, holes and other defects. Surfaces of casting shall be ground to assure proper fit and to prevent rocking.
 2. For manholes, use a bolted waterproof frame with a pressure tight cover. Bolted down frame and cover shall be installed as indicated on the Plans.

2.09 Steel Pipe

- A. Pipe shall conform to ASTM A53, black and hot-dipped galvanized welded and seamless pipe of standard weight.

2.10 Bolt, Studs, Nuts

- A. Bolt, studs, and nuts shall conform to the following ASTM Standards:
- B. Cadmium Plating: ASTM B766, Grade N.S.
- C. Zinc Coating: ASTM A153 or B663, Type G.S.

2.11 Concrete

- A. In accordance with MDOT Section 701, use Grade S2; 3,500 psi (24 MPa) strength; Type IA cement; 6.0 sacks cement per cubic yard (355 kg/m³); 6A coarse aggregate; 2NS fine aggregate; 6.5% ± 1.5% air content; 3-inch (75 mm) maximum slump; no admixtures without ENGINEER's approval.

2.12 Concrete Reinforcement

- A. In accordance with MDOT Section 905, use ASTM A615, Grade 60 for bars and ASTM A185 for welded wire fabric.

2.13 Flowable Fill

- A. Flowable Fill for Filling abandoned Sanitary Sewers:
 1. Materials:
 - a. Cement: Cement shall conform to ASTM C150 or ASTM C595
 - b. Fly Ash: Fly ash shall have a maximum loss on ignition of 12 percent and meeting the other requirements of ASTM C618 (Class F)
 - c. Water: The water shall meet the requirements of ASTM C94

2. Mixture (Strength 50 to 100 psi) (345 to 690 kPa):
 - a. Fly Ash (Class F): 2,000 lbs/cyd (1185 kg/m³) (minimum)
 - b. Cement: 100 lbs/cyd (60 kg/m³) (minimum)
 - c. Water: Sufficient water to produce the desired flowability (approximately 700 lbs/cyd) (415 kg/m³)
- B. Temperature of the flowable fill mixture as manufactured and delivered shall be at least 50° Fahrenheit (10° Celsius).
- C. Flowable fill can be mixed by pugmill, central concrete mixer, ready mix truck, turbine mixer, or other acceptable equipment or method.
- D. CONTRACTOR shall submit a history of the mix design for seven day and 28 day strengths, together with any other technical information. The design mix shall also be included as part of CONTRACTOR's submittals for project.

Part 3 Execution

3.01 Verification of Excavation and Bedding

- A. Prior to the installation of sanitary sewer piping, structures, or materials, examine trenches and other excavations for the proper grades, lines, levels and clearances required to receive the new Work. Ascertain that excavation bottoms, compacted subgrades and piping bedding are adequate to receive the sanitary sewer materials to be installed. Correct defects and deficiencies before proceeding with the Work.

3.02 Existing Sanitary Sewers

- A. CONTRACTOR shall expose the existing sanitary sewer and structures to which the new Work is to be connected and notify ENGINEER of same. ENGINEER will verify the vertical and horizontal locations of the existing system and shall inform CONTRACTOR as to the necessary adjustments required to align the new sanitary sewer work with the existing system.
- B. Connecting to an existing manhole requires removing the existing flow channel and constructing a new flow channel as necessary.
- C. When connecting a new sewer to an existing sewer or a new building lead to an existing building lead, where the pipe joints are not compatible, use a "Fernco" rubber adapter. When connecting clay to clay, concrete to concrete or plastic to plastic, use stainless steel shear ring type couplers.

3.03 Verification of Pipe Class and Joints

- A. Prior to the installation of any sanitary sewer piping, ascertain that the class of pipe, joint material and bedding are as specified herein and as indicated on the Plans.

3.04 Preparation of Pipe Ends

- A. Outside surface of the spigot end and the inside surface of the bell end shall be cleaned and free of foreign material, other than sealant recommended by the manufacturer, prior to installation.

3.05 Examination of Material

- A. Pipe, frames, covers, accessories, and appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective or damaged material shall be rejected and removed from the Project by CONTRACTOR.

3.06 Installation - General

- A. Each section of pipe, when placed to grade and line, shall have firm bearing on the trench bedding throughout its length.
- B. Pipe shall be laid to the line and grade called for on the Plans. Each pipe as laid shall be checked by CONTRACTOR with line and grade pole or laser system to insure proper result is obtained. When employing a laser system, CONTRACTOR shall have an alternate and independent means of checking the line and grade. CONTRACTOR shall check line and grade every 100-feet minimum. The finished work shall be straight and shall be sighted through between manholes.
- C. Construction shall begin at the outlet end and proceed upstream with spigot ends pointing in direction of flow. Bell holes shall be excavated so that the full length of the barrel will bear uniformly on the bedding.
- D. Mechanical means shall be used for pulling home all pipe where manual means will not result in pushing and holding the pipe home. Mechanical means shall consist of a cable placed inside of the pipe with a suitable winch, jack, or come along for pulling the pipe home and holding the pipe in position.
- E. After laying of pipe, care shall be taken so as not to disturb its line and grade. Any pipe found off grade or out of line shall be re-laid.
- F. Cutting of pipe shall be done with approved tools and by approved methods suitable for the pipe material. Pipe cutting methods that produce a smooth, square-cut end without damage to the pipe and that minimize airborne particles shall be employed. Pipe cutting shall be performed using the recommendations of the manufacturer of the type of pipe materials being cut and according to the best trade practices. When cutting of pipe or fittings, care shall be taken to prevent damage to the lining and the exterior surface. Damage to either shall be cause for rejection of complete section.
- G. During the preparation of the pipe bedding and until the trench has been satisfactorily backfilled, the trench shall be kept free of water and sewage. A dewatering system, in accordance with Section 31 2319, Dewatering, shall be provided and maintained by CONTRACTOR. The dewatering system shall remain in operation until the trench is backfilled.
- H. Backfill shall be as indicated on the Plans and as specified in Section 31 2333, Trenching and Backfilling.

3.07 Pipe Laying

- A. Rigid Pipe:
 - 1. Installation of rigid pipe shall conform to ASTM C12. All pipe shall be jointed by means of a resilient gasket. The resilient gasket shall be lubricated and installed to form a watertight joint between the bell and spigot of the pipe. The bell of the pipe in place shall be cleaned and properly lubricated prior to the installation of

the next pipe spigot. The pipe shall be centered in the bell or groove. After the spigot is well entered into the bell and the gasket is fully compressed and brought to final shape, check the gasket for proper position around the full circumference of the joint. Complete installation by pushing the pipe tightly together to form a smooth and continuous invert.

2. Circular concrete pipe with elliptical reinforcement shall be installed with the lift holes on the top of the pipe. The manufacturer's marks designating the top and bottom of the pipe shall not be more than five (5) degrees from the vertical plane through the longitudinal axis of the pipe. After the pipe is installed, the lift holes shall be sealed with suitable concrete plugs and grouted.
3. When adapters are required to properly connect the new pipe to an existing pipe of other materials or manufacture, the nominal inside diameter of adapters shall be the same size as the nominal pipe diameter to which it is to be connected.

B. Flexible Pipe:

1. Installation of flexible pipe shall conform to ASTM D2321.
2. Except as otherwise specified herein, installation of ABS and PVC piping shall be made in complete accordance with the published installation guide of the pipe manufacturer.
3. Joints for ABS pipe shall be made by first applying a coat of primer to the inside of the socket and to the outside of the spigot end of the pipe.
 - a. Without delay, apply a coating of cement to the same surfaces in sufficient quantity that when the spigot is fully inserted into the socket, a bead of excess cement will form around the complete circumference of the outside junction of the spigot and socket.
 - b. Remove the excess cement and allow the assembly to cure 24 hours.
4. Joints for PVC pipe shall be made by using a lubricant immediately before joining.
 - a. Apply lubricant on the bell and spigot, coating the entire circumference of the bell and spigot bevel plus 1-inch (25 mm) behind the taper. Insert lubricated spigot into the bell, and using normal force insert spigot until insertion stripe mark is flush with the bell entrance.
5. When jointing ABS or PVC pipe, rotate the pipe when inserting it approximately 1/4 to 1/2 turns.
6. Taps to previously installed ABS and PVC pipes, where in-line fittings are not provided, shall be made with chemically welded saddle fittings unless otherwise indicated on the Plans.
 - a. Holes for saddle connections shall be by mechanical hole cutters, or by keyhole saw or saber saw.

- b. Holes for saddles shall be laid out with a template and shall be deburred and beveled to provide a smooth hole shaped to conform precisely to the fitting.
- c. After the cemented saddle has been fixed to the pipe surface, quickly install band clamps each side of the saddle and tighten.

3.08 Pipe Bedding

- A. After the bottom of trench has been excavated the pipe bedding material will be installed in accordance with Section 31 2333, Trenching and Backfilling. The pipe shall then be installed strictly in accordance with the manufacturer's recommendations. After the pipe is laid, the bedding shall be continued above the pipe as specified in Section 31 2333, Trenching and Backfilling. Particular care shall be taken to assure filling and tamping all spaces under, around and above the top of the pipe.
- B. A continuous and uniform bedding as specified in Section 31 2333, Trenching and Backfilling, shall be provided in the trench for all buried pipe.

3.09 Manhole Structures

- A. General:
 - 1. Construct sanitary sewer manhole and other sanitary structures to the grades, lines and levels indicated on the Plans, or as specified herein.
 - a. Structures shall be precast concrete, complete with concrete bases, reinforcing, frames, covers, and adjustment rings, as shown and as required for a complete installation.
 - b. Sanitary manholes as called for on the Plans shall carry a stub opening as specified herein.
 - c. Wye openings in manholes are prohibited unless indicated on Plans.
 - d. Sanitary sewer structures shall conform to the type of material and dimensions indicated on the Plans.
 - 2. Manholes shall be completed and ready for final inspection either before 600 feet (180 m) of additional sewer construction is completed or within one (1) week after the manhole is constructed, whichever comes first.
- B. Block Structures:
 - 1. Sanitary manholes may only be constructed with block where specifically shown on the plans or where approved by ENGINEER. The first course of concrete block shall be placed on the prepared base in a full bed of mortar. Mortar joints shall be full and closed in all courses. Courses shall be level throughout. Stagger joints in adjoining courses by one-half the length of the block as nearly as practicable. Joints shall be uniform in thickness throughout the structure. Strike all joints and properly point to provide true, smooth surfaces.

2. Prior to applying plaster coat, block shall be thoroughly wetted with water and the surface allowed to dry sufficiently to effect proper bonding.
3. Construct as detailed on the Plans.
4. Where precast doghouse sections cannot be used, the manhole shall be brick or block to eight (8) inches (200 mm) above top of highest pipe. Above that point manholes shall be precast concrete as shown on the plans.
5. Cement mortar plaster coat shall be applied to the exterior surfaces of all brick and/or concrete block sections of all manholes. Plaster coat shall be 1/2 inch (10 mm) thick.
6. Provide and install all cast iron covers, frames, adjusting rings, and anchors to the elevation indicated on the Plans, or as specified herein. Castings shall be set on 1-inch (25 mm) diameter rubber "O" ring gasket, resting on adjustment rings. The casting shall be anchored to the precast concrete cone section as indicated on the Plans.
7. Steps are to be installed at the plant by the manufacturer of precast units. Field install steps in other than precast structures of the types and in the locations indicated on the Plans.
8. Pipe, 6-inch through 24-inch (150 mm through 600 mm) diameters, shall be connected to manholes using an approved mechanically compressible flexible joint as indicated on the Plans. The pipe shall be properly supported with compacted pipe bedding material from undisturbed ground so that any settlement will not disturb the connection.
9. Pipe, 27-inch through 42-inch (675 mm through 1050 mm) diameters, or pipe in brick or block manholes, shall be connected to manholes using a grouted joint as indicated on the Plans. The pipe shall be properly supported with 3,500 psi (24 MPa) concrete from undisturbed ground so that any settlement will not disturb the connection.
10. The joint for existing pipe, 6 inches (150mm) in diameter and larger, over which the sanitary manhole will be constructed, shall be a grouted joint as indicated on the Plans.
11. Pipe, 48 inches (1200 mm) in diameter or larger, shall be installed as an integral part of the manhole which shall be constructed of 3,500 psi (24 MPa) concrete placed in one continuous pour to 1-foot (300 mm) above the top of pipe as indicated on the Plans.
12. Concrete flow channels shall be constructed in each manhole, as indicated on the Plans. For manholes with outlet pipe diameter of 24 inches (600 mm) or less, construct concrete flow channel straight through a manhole to conform as closely as possible in shape, and slope to that of the connecting sewers. The channel walls shall be formed or shaped to the full height of the crown of the outlet sewer in such a manner to not obstruct maintenance, inspection or flow in the sewers. The concrete flow channel shall be constructed with a 3/4 inch to 1-1/4 inch (20 mm to 30 mm) gap provided at the pipe ends to maintain joint flexibility.

13. For manholes with outlet pipe diameters from 27 inches to 42 inches (675 mm to 1050 mm) or for manholes constructed over existing sewers to 42 inches (1050 mm) in diameter, the channel shall be constructed by filling around the pipe to the spring line and splitting the pipe at the spring line and removing the top half after the manhole is constructed.

3.10 Sanitary Sewer Stub Opening

- A. Stub openings shall be at least 2 pipe lengths, with a minimum length of 10 feet (3 m) (unless otherwise indicated on the Plan), and the first joint located approximately 18 inches (450 mm) from the outside manhole wall. The end of the stub shall have a manufactured bell, which shall be plugged with a watertight manufacturer plug that is blocked to prevent movement.

3.11 Vent Assembly

- A. Provide materials and construct vent assemblies where indicated on the Plans. Install piping, fittings, joints, vents, etc., as detailed. Vent assemblies shall be installed on undisturbed earth and provided with restraints as indicated on the Plans, and as required for a complete installation. Vent assemblies shall be connected to manholes as indicated on the Plans.

3.12 Drop Connection Assembly

- A. Provide materials and construct drop connection assembly where indicated on the Plans. Install piping, fittings, joints, etc., as detailed.
- B. Tapping of existing manholes for drop connections shall be made by drilling holes through the wall of the manhole at 4-inch (100 mm) centers along the periphery of the opening, to create a plane of weakness joint, before breaking out section. Nonshrink grout shall be used to seal the opening and a 3,500 psi (24 MPa) concrete collar 12 inches (300 mm) thick shall be poured around the pipe. Drop connections to existing or new manholes shall be made as indicated on the Plans.

3.13 Bulkheads

- A. A solid masonry or approved water and airtight bulkhead shall be placed at each point of beginning and at each stub that is constructed or as indicated on the Plans.
- B. At the completion of construction and testing, the bulkheads shall be removed, unless otherwise indicated on the Plans or as directed by ENGINEER.

3.14 Wyes

- A. One 6-inch (150 mm) wye or tee branch shall be provided for each lot or parcel 100 feet (30 m) or less in width that is served by the sewer or every hundred feet (30 m) for lots or parcels in excess of 100 feet (30 m) in width that is served by the sewer, unless otherwise indicated on the Plans or specified.
- B. In all cases, unless otherwise indicated, wyes shall be placed as near as practical to the lower 1/3 point of vacant lots or parcels to be served, and it shall be the responsibility of CONTRACTOR to see that the wyes are so placed. Wyes to developed lots or parcels shall be placed at the location nearest the existing sanitary service lead.

- C. If CONTRACTOR fails to place any wyes as herein outlined he shall return to the site and place additional wyes, in an approved manner, at his expense.
- D. If a concrete pipe with an inset opening is being used, a compression type joint shall be cast into bell end of the opening. Wye openings shall be closed with a 6-inch (150 mm) stopper, as recommended by the manufacturer, to make a watertight closure.

3.15 Risers

- A. Risers shall be installed where the sewer is more than 12 feet (3.5 m) below the established grade or future grade, and carried to between nine (9) and ten (10) feet (2.5 m to 3.0 m) of the established grade or future grade, as indicated on the Plans. Six (6) inch (150 mm) pipe with approved compression type joints, shall be installed in the manner indicated on the Plans.
- B. Riser openings shall be closed with a stopper, as recommended by the manufacturer, to make a watertight closure.

3.16 Building Leads

- A. Building leads shall be 6-inch (150 mm) diameter pipe and shall be laid on a uniform slope of 1/8 inch per foot (10 millimeters per meter) unless greater slope will provide depth considered adequate by NGINEER.
- B. Building leads shall be provided to within 1-foot (300 mm) of property line for all lots or parcels on both sides of the street, unless otherwise indicated on the Plans. If in an easement, the lead shall be provided to within 1-foot (300 mm) of the easement line.
- C. Building lead depth, four-(4) feet (1.2 m) horizontal from property line or permanent easement line, shall be between eight (8) and nine (9) feet (2.5 m to 3.0 m). From this point, a 45-degree bend shall be placed and a short length of pipe such that the end depth will be between five (5) and six (6) feet (1.5 m to 1.8 m).
- D. Building leads under or within five (5) feet (1.5 m) of concrete or asphalt pavements shall be installed by boring or tunneling.
- E. Each building lead shall be closed with a stopper, as recommended by the manufacturer, to make a watertight closure.

3.17 Wye, Riser or Building Lead Marker

- A. Unless otherwise indicated in the Plans or Specifications, prior to the backfilling of a wye, riser or building lead, a 2" x 2" (50 mm x 50 mm) (minimum cross section) wooden marker shall be placed from a point immediately in front of the service connection to 1-foot (0.3 m) below the finish ground surface. Do not rest the marker on any portion of the service connection or stopper.

3.18 Abandoning Sanitary Sewer with Flowable Fill

- A. Install a bulkhead in each end of the sanitary sewer to be abandoned leaving a small opening in the very top of each bulkhead
- B. Install a minimum 2-inch (50 mm) diameter stand pipe in the top of the bulkhead of the sanitary sewer to be abandoned. The stand pipe should be installed such that it can be removed after use and the hole sealed.

- C. Install a minimum 2-inch (50 mm) air release pipe in the bulkhead in the opposite end of the sanitary sewer from the stand pipe. The air release pipe should bend up to a 90 degree angle with the end of the pipe being a minimum of six inches (150 mm) above the top of the sanitary sewer.
- D. Using the stand pipe, pump flowable fill into the sanitary sewer to be abandoned. The flowable fill shall be pumped into the sanitary sewer until free water flows from the air release pipe at the opposite end.
 - 1. Continue filling the sanitary sewer until the material released at the air release pipe is representative of the flowable fill being introduced at the fill end of the sanitary sewer.
- E. Remove the stand pipe and air release pipe and plug the hole in both bulkheads.

3.19 Abandon Existing Manholes

- A. Manholes on the existing sanitary sewer shall be abandoned and the structures shall be removed in accordance with the following:
 - 1. Removal of existing structures shall consist of removing and salvaging the existing frame and cover.
 - 2. Ends of the existing sanitary sewer shall be bulkheaded. Masonry shall be broken down to an elevation at least 30-inches (750 mm) below the proposed subgrade or finished grade.
 - 3. Abandoned structure shall be backfilled with flowable fill to 1-foot (0.3 m) above the pipes and the remainder of the structure with sand-cement mixture at a 10 to 1 ratio to subgrade elevation.

3.20 Field Quality Control

- A. General:
 - 1. After pipe, structures, and leads have been laid, constructed and backfilled, the system shall be final inspected and tested. Inspection and testing shall consist of the following parts: first inspection, television inspection and testing.
 - 2. The first inspection shall be completed and all repairs made in ample time so that the television inspection of the underground portion of the system, can be completed within 4 weeks of the completion of the construction. Television inspection shall be considered completed when the necessary construction repairs have been made and the installation re-televised when required, and the system is acceptable for the testing phase. When re-television is necessary, an additional 2 weeks will be allowed for completion. Testing of the system shall immediately follow the television inspection and shall be completed within a 2-week period.
 - 3. Failure to maintain a schedule in compliance with this specification will automatically cause the stoppage of other work at the particular site in question until such time as the final inspection of the completed underground portion of the system has progressed to within acceptable limits.

B. First Inspection:

1. CONTRACTOR shall have the underground portion of the sewer system ready for the first inspection within 2 weeks after the completion of each 2,000-foot (600 m) section of sewer installed.
2. The first inspection shall consist of a visible and audible check of the sewers and manholes to ascertain that the manhole steps have been placed, lift holes jointed, the channeling of the manhole bottoms completed, visible or audible leaks stopped, pipe has been placed straight and true to the proper grades and elevation, the required adjusting rings and frame and cover properly installed, trenches and structures backfilled in a workmanlike manner and that the system has been thoroughly cleaned.
3. The first inspection shall be considered completed when all the repairs have been made and the system is ready for television inspection.

C. Television Inspection:

1. CONTRACTOR shall provide for television inspection of the various sanitary sewer lines installed under this Contract.
2. CONTRACTOR shall arrange for, engage and pay all expenses involved for the services of a competent company to perform this television inspection.
3. The television inspection shall be observed by representatives of OWNER, ENGINEER, and CONTRACTOR. Any television viewing performed in the absence of ENGINEER will not be considered as a part of the final inspection.
4. The inspection shall involve the visual observation by closed-circuit television of all sanitary sewer, eight (8) inches (200 mm) in diameter to 30 inches (750 mm) in diameter inclusive, installed as a part of this Contract.
5. The inspection shall be performed at a maximum rate of speed of 30-feet per minute, which will allow examination of all points of infiltration, cracked or crushed pipe, defective joints, misalignment in line or grade, location of all wye openings and any defects or items of poor workmanship which may appear. Prior to television inspection, CONTRACTOR shall run water down the line to show any dips or high spots in the line. Water shall be run continuously during television inspection if necessary to determine changes in grade in the line.
6. Items which, in the opinion of ENGINEER, require repair shall be precisely located and photographed along with a detailed statement of the condition.
7. CONTRACTOR shall take immediate action to repair all such defects including excessive infiltration at any specific location, even though the infiltration limits as herein specified have not been exceeded for the entire length of sewer being inspected. Following completion of the repair, OWNER or ENGINEER, at their discretion, may require a second television inspection of any repaired areas. CONTRACTOR shall arrange for and pay all costs involved in performing this re-inspection.
8. As a part of the television inspection, the precise location of each wye shall be noted in relation to the downstream manhole.

- a. These locations shall be entered on the Wye Location Sheet as supplied by ENGINEER and verified by comparison with the locations as established at the time of construction.
 - b. Discrepancies in location between the field location record and the television inspection record shall be reconciled and the proper location of the wye determined as a part of the television inspection.
 - c. Two (2) copies of all notes, photographs, wye locations and other pertinent information shall be made as a part of the television inspection.
 - (1) One set of this information shall be turned over to the representative of ENGINEER upon the completion of the inspection of each line.
 - (2) The second copy of the information shall be held by the television inspection company until completion of the project, at which time it shall be neatly assembled and turned over to ENGINEER as a complete, comprehensive report on the television inspection of the project.
9. Television inspection shall be recorded and shall be submitted in the format(s) as specified by ENGINEER.
- a. DVD Disk:
 - (1) Audio/video route survey submission shall be on DVD media meeting the following specifications:
 - (a) Media: DVD-R or DVD+R, 4.7GB, single layer
 - (b) Format: DVD – Video
 - (c) Video Encoding: Highest available bit rate (6-9 Megabit), 60 fields per second interlaced video
 - (d) Audio Encoding: Uncompressed stereo wave or stereo Dolby Digital (256 kilobit or better)
 - (e) Aspect Ratio: 4x3 (720x480 pixels)
 - (f) No Macrovision or other copy protection encoding. No region code or region code 1.
10. Television inspection shall be considered completed when the necessary construction repairs have been made and the installation retelevised when required, and the system is acceptable for the testing phase.

D. Testing:

- 1. CONTRACTOR shall provide the necessary supervision, labor, tools, equipment and the materials necessary for the tests which shall be conducted in the presence of ENGINEER. ENGINEER shall be notified two (2) working days in advance of all testing. The following tests shall be performed and approved prior to placing any system in service:

- a. Leakage tests shall be conducted on all new sewer lines and existing lines which have not been previously approved.
- b. Sewers shall be subjected to air, exfiltration or infiltration tests, or a combination of same, prior to acceptance.
 - (1) Sewers over 24-inch (600 mm) diameter shall be subjected to infiltration tests.
 - (2) Sewers of 24-inch (600 mm) diameter or smaller, where the groundwater level above the top of the sewer is over 7 feet (2m), shall be subjected to infiltration tests.
 - (3) Sewers of 24-inch (600 mm) diameter or less, where the groundwater level above the top of the sewer is 7 feet (2 m) or less, shall be subjected to air tests or exfiltration tests.

2. Exfiltration/Infiltration Test:

- a. Exfiltration and Infiltration testing will be performed in accordance with ASTM C1091 except as specified herein. If an exfiltration test is performed, the maximum exfiltration rate shall be the same as the permitted from infiltration. For the purposes of exfiltration testing, the internal water level shall be equal to the external water level plus 7feet (2 m) as measured from the top of pipe, and the elevation must be at least as high as the highest house service.
- b. Maximum allowable infiltration shall not exceed 100 gallons per inch of diameter per mile of pipe between manholes per 24 hours (18.5 L/mm diameter/km length/24 hours) for any section of the system and shall include the infiltration from all manholes and other appurtenances.

3. Air Test:

- a. The procedure for air testing of sewers shall be in accordance with ASTM C828 for Vitrified Clay Pipe, ASTM C924 for Concrete Pipe, and ASTM F1417 for Plastic Pipe except as follows:
- b. House leads shall be properly plugged and blocked to withstand the air pressure. The sewer line shall be tested in increments between manholes. The line shall be cleaned and plugged at each manhole. Such plugs shall be designed to hold against the test pressure and shall provide an airtight seal. One (1) of the plugs shall have an orifice through which air can be introduced into the sewer. An air supply line shall be connected to the orifice. The air supply line shall be fitted with suitable control valves and a pressure gauge for continually measuring the air pressure in the sewer. The pressure gauge shall have a minimum diameter of 3-1/2 inches (90 mm) and range of 0 - 10 psig (0 to 70 kPa). The gauge shall have minimum divisions of 0.10 psig (0.5 kPa) and an accuracy of ± 0.04 psig (0.2 kPa).

- c. The sewer shall be pressurized to an initial test pressure of 4.0 psig (27.5 kPa) greater than the greatest back pressure caused by groundwater over the top of the sewer pipe. At least 2 minutes shall be allowed for the air pressure to stabilize. If necessary, air shall be added to the sewer to maintain a pressure within 1.0 psig (7 kPa) of the initial test pressure.
 - d. After the stabilization period, the air supply control valve shall be closed so that no more air will enter the sewer. The sewer air pressure shall be noted and timing for the test begun. The test shall not begin if the air pressure is not within 1.0 psig (7 kPa) of the initial test pressure.
 - e. The time required for the air pressure to decrease 1.0 psig (7 kPa) during the Test shall not be less than the time calculated from Table 1 and the Appendices of the applicable ASTM standard as noted above.
 - f. Manholes on sewers to be subjected to air tests shall be equipped with a 1/2 inch (10 mm) diameter galvanized capped pipe nipple extending through the manhole wall, three (3) inches (75 mm) into the manhole and at an elevation equal to the top of the sewer pipe. Prior to the air test, the groundwater elevation shall be determined by blowing air through the pipe nipple to clear it and then connecting a clear plastic tube to the pipe nipple. The tube shall be suspended vertically in the manhole and the groundwater elevation determined by observing the water level in the tube. The air test pressure shall be adjusted to compensate for the maximum groundwater level above the top of the sewer pipe to be tested. After all tests are performed and the sewer is ready for final acceptance, the pipe nipple shall be removed and the hole in the manhole wall shall be plugged with hydraulic cement.
- 4. If a sewer fails to pass any of the previously described tests, CONTRACTOR shall determine the location of the leaks, repair them and retest the sewer. The tests shall be repeated until satisfactory results are obtained.

3.21 Deflection Test for Plastic Pipe

- A. Plastic pipe shall be tested for deflection, but no sooner than 30 days following the backfilling of the pipe.
 - 1. Maximum allowable deflection (reduction in vertical inside diameter) shall 5 percent.
 - 2. Locations with excessive deflection shall be excavated and repaired by re-bedding and/or replacement of the pipe.
 - 3. Optional devices for testing include a deflectometer, calibrated television or photography, or a properly sized "go, no-go" mandrel or sewer ball. Mandrel shall have a minimum of 9 legs.

End of Section

Section 33 3400

Sanitary Utility Force Mains

Part 1 General

1.01 Scope of Work

- A. This Section includes underground force main work complete with piping, valves, force main manholes, fittings, thrust blocks, retainers, plugs and accessories required for installation as indicated on the Plans and specified herein. This Section also includes hydrostatic testing of completed portions of new force main.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200: Unit Prices
- B. Section 31 2316: Structural Excavation and Backfill
- C. Section 31 2319: Dewatering
- D. Section 31 2333: Trenching and Backfilling
- E. Section 31 7000: Tunneling and Mining
- F. Section 04 0511: Mortaring and Grouting

1.03 Reference Standards

- A. Unless otherwise specified, the Work of this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. ANSI - American National Standards Institute
 - 2. ASTM - ASTM International
 - 3. AWWA - American Water Works Association
 - 4. MDOT - Michigan Department of Transportation, Standard Specifications for Construction, latest addition

1.04 Submittals

- A. Tabulated Laying Schedule:
 - 1. Tabulated Laying Schedule, showing stationing, deflection, elevation, slope and description of pieces (i.e., pipe size and material; fitting type, size and material; valve type and size, etc.) shall be submitted to ENGINEER. Pipe manufacture shall not be started until the laying schedule has been reviewed by ENGINEER.
- B. Product Data:
 - 1. Submit catalog data showing pipe sizes, and manufacturing standards, as well as design calculations for internal pressure, vacuum and external load conditions, for both non-restrained and restrained joints.
- C. Quality Assurance Materials:
 - 1. Quality assurance test procedures, test reports for pipes, specials and fittings shall be submitted to ENGINEER.

D. Affidavits:

1. Affidavits of compliance with the Contract Documents shall be submitted to ENGINEER and shall include the following, where applicable:
 - a. Pipes, specials and fittings (AWWA C200).
 - b. Cement-mortar protective lining (AWWA C205 and AWWA C602).
 - c. Tape coating for the exterior (AWWA C214 and AWWA C209).
 - d. Shrink wrap for exterior (AWWA C216).
 - e. Paint system for the exterior (AWWA C210, C218 or C222).
 - f. Manufacturer's standard repair procedures.
 - g. Manufacturer's written quality control procedures.
 - h. Manufacturer's Installation Instructions: Indicate special installation requirements.
 - i. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.
2. Affidavits for items a through e shall be signed by an authorized professional.

1.02 Closeout Submittals

- A. The following shall be submitted in accordance with Section 01 7700, Closeout Procedures:
 1. Manufacturer's field reports.
 2. Project record documents:
 - a. Accurately record actual locations of piping mains, valves, connections, and invert elevations.
 - b. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.
 3. Provide a final record laying schedule.
 4. Submit certified copies of hydrostatic test results of completed force main sections as specified in Article 3.15.

1.05 Delivery of Materials

- A. For pre-stressed concrete pipe provide 2 percent of pipe lengths to be delivered as short pieces with 10 feet (3 m) or less. These short pieces shall be in addition to those required under the tabulated laying schedule.

1.06 Storage of Materials

- A. Pipe shall be stored in a manner to minimize infiltration of dirt, debris, and other extraneous materials.
- B. Piping materials shall not be stacked higher than 4 feet (1.2 m). Suitable racks, chairs, and other supports shall be provided to protect performed pipe mating surfaces from damage. Store bottom tiers off the ground, alternate tiers, and chock tier ends.
- C. Joint and sealing materials subject to ultraviolet or ozone attack and used in the force main system shall be protected from the sunlight, atmosphere and weather, and stored in suitable enclosures until ready for installation.

1.07 Handling of Materials

- A. Load and unload piping using suitable hoists and skidding. Piping shall not be dropped, bumped or allowed to impact against itself. Damaged piping shall not be used by CONTRACTOR.
- B. Lifting devices shall be suited to the Work and shall protect surfaces from damage.

1.08 Environmental Requirements

- A. Cast iron or ductile iron pipe joints shall comply with the requirements due to outside ambient air temperatures specified under Article 3.05 of this Section.

Part 2 Products

2.01 General

- A. It is the intent of the Articles in Part 2 of this specification section is to specify in detail the various types of pipe, joints, and fittings which have been indicated throughout the Plans and Specifications. These Articles shall not be construed as allowing any alternate type of material to that which is indicated on the Plans or elsewhere in the Specifications.

2.02 Ductile Iron Pipe

- A. Ductile iron pipe shall be ANSI/AWWA C151/A21.51, with double thickness cement mortar lining inside and 1-mil (25 µm) minimum thickness asphaltic coating outside. Pipe shall have a minimum wall thickness class for the pipe nominal inside diameter as indicated on the Plans.
- B. Mechanical joints for ductile iron pipe shall be compression gasket type, conforming to ANSI/AWWA C111/A21.11 except that slots with the same width as the diameter of the bolt holes in mechanical joints shall not be allowed in the bell flange.
- C. Push-on joints for ductile iron pipe shall be compression gasket type conforming to ANSI A21.11 with spigot of pipe marked to visually determine when the spigot is fully seated in the bell of the adjoining section.
- D. Fittings and plugs shall be ductile iron, mechanical joint, pressure rating of 350 psi (2.4 MPa), conforming to ANSI/AWWA C153/A21.53, and ANSI/AWWA C111/A21.11, with double thickness cement mortar lining and coal tar enamel coating on the outside of fittings.

- E. Nuts and bolts shall be high strength low-alloy steel conforming to ANSI/AWWA C111/A21.11.
- F. Flexible ball and retainer type joints shall be ball and retainer type, boltless, locking, and capable of being deflected up to 15 degrees.
- G. Flange joints shall have full face neoprene gaskets, 1/8-inch-thick and conform to ANSI B16.1. Carbon steel bolts shall conform to ASTM A449 with nuts conforming to ASTM A563 Grade B. Stainless steel bolts and nuts shall conform to ASTM A320. Bolt head and nuts shall be hex. Piping connection bolts and nuts used on this Project including piping in the wet areas shall be cadmium plated. Flange joints shall not be buried.
- H. Cement mortar lining for cast iron and ductile iron piping shall conform to the requirements of ANSI/AWWA C104/A21.4 of the thicknesses specified and shall be permanently set prior to the application of additional pipe coating.

2.03 Prestressed Concrete Pipe Systems

- A. Concrete pipe shall be prestressed concrete, embedded cylinder type, 175 psi plus load design pressure conforming to AWWA C301. Seal coat in accordance with ANSI/AWWA C104/A21.4 as applicable.
- B. Joints for concrete pipe shall be push-on, steel ring, gasket type conforming to AWWA C300 or AWWA C301.
- C. Fittings shall be AWWA C300, Type A, concrete or mortar lined with reinforced concrete or mortar exterior covering. AWWA C300, Type B, cut and welded steel plate mortar coated on interior and exterior.
- D. Seal coat concrete pipe with bitumastic concrete penetrant conforming to ANSI/AWWA C104/A21.4. Apply after pipe has cured.

2.04 Polyvinyl Chloride (PVC) Piping Systems

- A. Rigid polyvinyl chloride bell and spigot type pressure pipe and couplings conforming to ASTM D2241, SDR 21, pressure class 200, unless indicated otherwise in the Contract Documents. Spigot end of pipe shall be marked to visually determine when the spigot is fully seated in the bell of the adjoining pipe.
- B. Joints for PVC pipe shall be Push-on, elastomeric gasket type, conforming to ASTM D3139.
- C. PVC fittings shall only be allowed when called for on the plans. When allowed, PVC fittings shall be SDR-21, conforming to ASTM D2241, D3139 and F477.
- D. Fittings for PVC pipe, unless specified otherwise, shall be Class 250 psi, manufactured of ductile iron, grade 80-55-06 in accordance with ASTM A536. Fittings shall have mechanical joints with gaskets meeting ASTM F477. Fittings shall have radii of curvatures conforming to ANSI/AWWA C153/A21.53 and shall be cement lined in accordance with AWWA C104.
- E. Gaskets for PVC pipe shall be elastomeric seal type conforming to ASTM F477.
- F. Pipe joint lubricant shall be manufacturers standard nontoxic.

2.05 Subaqueous Pipe

- A. Pipe shall be ductile iron, ANSI/AWWA C151/A21.51, with double thickness cement mortar lining and 1-mil (25 µm) thickness minimum of coal tar enamel inside and outside. Pipe shall have a minimum wall thickness class for the pipe nominal inside diameter as indicated on the Plans.
- B. Bell assembly shall conform to ANSI/AWWA C153/A21.53, threaded onto pipe in accordance with ANSI B2.1. Spigot shall have raised bead cast with the pipe and machined to form shoulder.
- C. Joint shall be made by a retaining ring and gasket assembly compressed between an outer ring and the shouldered spigot. Steel retaining rings shall seat the gasket inside the spherical bell and provide a positive stop for the spigot. Gasket shall be a high quality molded rubber and duck tipped. Tee head bolts and hexagonal nuts shall be stainless steel.

2.06 Restrained Joints

- A. Where the plans or specifications call for restrained joints they shall be per the following.
- B. Restrained joints for ductile iron pipe and fittings shall be designed for a working pressure of 350 psi (2.4 MPa). Joints shall be capable of being deflected after assembly. Restraints shall be by a positive axial lock between the bell interior surface and a retainer weldment on the spigot end of the pipe.
- C. Restrained joints for PVC force main pipe shall be designed for a working pressure of 200 psi (1.4 MPa). Where the restrained portion of the pipe is connected to fittings, restraint shall be provided across the joint by a clamping ring and anchored to the fitting with T-head bolts or stainless-steel rods. Restraining devices for PVC water main pipe shall incorporate clamping rings with serrations on the inside surface to provide positive restraint on the outside surface of the pipe and shall provide full support around the circumference of the pipe to maintain roundness.

2.07 Polyethylene Encasement

- A. Polyethylene material for encasement shall be either 4 mil high density, cross-laminated polyethylene film or 8 mil linear low-density polyethylene film per ANSI/AWWA C105/A21.5.

2.08 Gate Valves

- A. Provide iron body, resilient seated, solid wedge type gate valves with non-rising stems and O-ring seals in accordance with AWWA C509.
- B. Furnish buried valves with mechanical joint ends, stainless steel hardware, and 2" square operating nut. Where the force main is buried at a depth where the normal valve operating nut will be at a depth greater than 5-1/2 feet, a valve extension stem with operating nut shall be provided and mechanically attached to the valve to provide an operating nut at the 5-1/2-foot depth.
- C. Valves shall open counterclockwise.
- D. Gate valves shall be as manufactured by East Jordan, or equal.

2.09 Eccentric Plug Valves

- A. Valve body shall be full ported, cast iron and comply with AWWA C504. Inlet and outlet connections shall be compatible with the pipe joints used.
- B. Body seats shall be synthetic rubber reinforced by a nickel alloy conforming to ASTM B127. Seats shall be adequately reinforced and secured to the body to prevent the seat from becoming inflated by the pressure from behind.
- C. Bearings shall be replaceable sleeve-type with one set being thrust resistant to hold the plug securely in the center of the seat. Self-lubricated bearings shall have proven record of durable service.
- D. Shaft seals shall conform to AWWA C504 and C507.

2.10 Air Release Valve

- A. Air Release valves shall have an ASTM A126 Class B cast iron body and cover with a threaded inlet connection of the size shown on the plans or listed in the schedule and a 1/2-inch NPT outlet connection. Valve body shall have a 2-inch NPT plugged port near the base to facilitate cleanout of large solids as well as a 1/2-inch NPT connection near the top and 1-inch NPT port near the bottom to permit the installation of flushing attachments.
- B. Valves shall have an 18-8 stainless steel float and a replaceable seat of Buna-N or other suitable material. Internal linkage mechanism shall be 18-8 stainless steel, plastic or bronze is not acceptable. Linkage mechanism shall be capable of being removed from the cover without disassembly of the mechanism. Valves shall have 3/16-inch diameter stainless steel orifice for working pressures up to 150 PSI.
- C. Provide flushing attachments to include 1/2-inch flushing valve, 1-inch blowoff valve, 5 feet of rubber hose and quick disconnect couplings.
- D. Valve shall automatically exhaust accumulated air from a fluid system while the system is pressurized and operational.

2.11 Combination Sewage Air Release and Vacuum Valves

- A. Wastewater combination air valves shall be constructed of cast iron body and cover, stainless steel plug, guide shaft, bushings and float, Buna-N seat.
- B. Valves shall be automatic float operated valve designed to releases air, gas or vapor during filling of a force main and close upon liquid entry, and allow air to re-enter when draining or under a negative pressure.
- C. Valve shall also release accumulated air from a force main while the system is in operation and under pressure. Valves shall have working pressure of 150 psi (1000kPa).
- D. CONTRACTOR shall provide a backwash system to be included with the valves consisting of an inlet shut-off valve, blow-off valve, clear water inlet valve and rubber supply hose with quick disconnect couplings.

2.12 Concrete Brick

- A. Concrete brick shall be ASTM C55, Grade S-II, solid units of nominal 3-inch (75 mm) thickness.

2.13 Concrete Block

- A. ASTM C139, Type II, shape and scored as detailed and as approved.

2.14 Precast Concrete Units

- A. Precast concrete units, flat top slabs, riser, cone, transition sections and bottom sections shall conform to ASTM C478, and shall be circular with circular reinforcement. For depths greater than 32-feet, the manhole shall be designed for the earth loading at the design depth of bury with a factor of safety of 1.5. Base slab shall be eight (8) inches (200 mm) thick for depths up to 25 feet (7.5 m) and 12 inches (300 mm) thick for depths greater than 25 feet (7.5 m).
- B. Transition sections, reducers and flat top slabs shall be designed for the earth loading at the design depth of bury with a factor of safety of 1.5.
- C. Precast bottom sections shall be cast with the bottom end flat to provide bearing of the full wall thickness. Openings for sewer pipe shall be cast in the manhole and the bottom section by the manufacturer.
- D. Riser sections of a manhole shall have modified grooved tongue joints with "O" ring gaskets.
- E. Eccentric cone sections of a manhole shall have modified grooved tongue joints with "O" ring gaskets and be provided with 4-stud inserts cast in the top. The top shall have a smooth finished surface.
- F. Concrete grade rings shall have smooth finished top and bottom surfaces. Grade rings shall be provided with "O" ring gaskets.

2.15 Manhole Steps

- A. Cast iron manhole steps shall be ASTM A48, Class 35, with a minimum cross section dimension of 1-inch (25 mm) in any direction.
- B. Steel Reinforced plastic manhole steps shall be suitably approved co-polymer polypropylene conforming to ASTM D4101, PP0344B33534Z02 with 1/2 inch (12 mm) minimum diameter deformed reinforcing bar conforming to ASTM A615, Grade 60 and shall be in accordance with ASTM C478.
- C. Manhole steps shall be of types and sizes indicated on the Plans and shall comply with applicable state and federal occupational and safety standards.

2.16 Covers and Frames

- A. Structure frame and covers shall be of the types and sizes as detailed on the Plans. Covers shall be Class 30, ASTM A48 gray iron castings. The castings shall be neatly made and free from cracks, cold sheets, holes and other defects. Surfaces of castings shall be ground to assure proper fit and to prevent rocking.

2.17 Valve Boxes

- A. Three-piece, 5-1/4-inch (135 mm) diameter, screw type, gray iron castings conforming to ASTM A48, Class 20 with adjustable length. Lids shall have "Sanitary Force Main" plainly cast in tops.

2.18 Concrete

- A. In accordance with MDOT Section 701, use Grade S2; 3,500 psi (24 MPa) strength; Type IA cement; 6.0 sacks cement per cubic yard (355 kg/m³); 6A coarse aggregate; 2NS fine aggregate; 5% ±1% air content; 3-inch (75 mm) maximum slump; no admixtures without the ENGINEER's approval.

2.19 Concrete Reinforcement

- A. In accordance with MDOT Section 905, use ASTM A615, Grade 60 for bars and ASTM A185 for welded wire fabric.

2.20 Restraints, Clamps, Rods, and Ties

- A. Cast iron or stainless steel as recommended by pipe manufacturer. Bolts, nuts, clamps, rods, ties and fittings shall be bronze alloy or corrosion protected steel.

2.21 Tracer Wire

- A. Copper clad steel wire with 30 mil High Density Polyethylene (HDPE) insulation. Concentric copper cladding metallurgically bonded to a steel core through a continuous solid cladding process.
- B. Copper cladding to measure 3% minimum of the overall wire diameter. Wire to be 12 AWG, 0.0808 in. diameter, 0.00242-inch nominal copper thickness, 9.5270 ohms nominal resistance per 1,000 feet, 675 pounds breaking strength.
- C. Wire to be Copperweld® or equal.

2.22 Acceptable Manufacturers

- A. PVC Pipe Transition Gland or Gasket: Acceptable manufacturers include Mueller, Tyler, or equal.
- B. Combination Air Valves: Acceptable manufacturers include Apco, Val-matic, or equal.
- C. Valve Boxes: Acceptable manufacturers include Clow "F-2450," or equal.
- D. Restrained Joints: Acceptable manufacturers for restrained joints for ductile iron pipe include Griffin Pipe Products Company, "Snap-Lok" or "Bolt-Lok"; American Cast Iron Pipe Company, "Lok-Ring" or "Lok-Fast"; United States Pipe and Foundry Company, "TR Flex"; Ebaa Iron "Megalug" or ENGINEER approved equal.
 - 1. Manufactured in accordance with ANSI/AWWA C111.
 - 2. A tightly adherent, corrosion resistant coating shall be used on all exposed metal components of the restrained joint system.

- a. Wedges, actuating hardware or other exposed threaded components shall be coated with a minimum of two (2) coats of fluoropolymer epoxy coating that has been heat cured.
 - b. Primary restraint castings shall be coated with a polyester coating, electrostatically applied and fusion bonded.
 - c. Bolts, nuts, and washers shall be manufactured of low-alloy steel conforming with the material characteristics listed in ANSI/AWWA C11 and shall have a minimum of two (2) coats of fluoropolymer epoxy coating that has been heat cured.
- E. Fittings for IPS/PVC Pipe: Harco manufactured by the Harrington Corporation.

Part 3 Execution

3.01 CONTRACTOR's Verification

- A. Prior to the installation of any force main piping or materials, examine all trenches and other excavations for the proper grades, lines, levels and clearances required to receive the new Work. Ascertain that excavation bottoms, compacted subgrades and pipe bedding are adequate to receive force main materials to be installed. Correct defects and deficiencies before proceeding with the Work.

3.02 Preparation of Pipe Ends

- A. Remove all lumps, blisters and excess coatings from the socket and plain ends of pipe. Wire brush and wipe clean the outside surfaces of plain ends and the inside surfaces of socket ends before installation. Pipe or fitting which has acquired a coating of mud or other adhesive foreign material shall be scrubbed clean.

3.03 Examination of Materials

- A. Pipe fittings, accessories, and appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective or damaged materials shall be rejected and removed from the Project by CONTRACTOR.

3.04 Installation - General

- A. Foreign matter shall be prevented from entering the pipe while it is being placed in the trench. During and after laying operations, no debris, clothing or other materials shall be placed in the pipe. Plug pipe ends when construction stops overnight or for extended periods.
- B. Each section of pipe, when placed to grade and line, shall have firm bearing on the trench bedding throughout its length between bell holes.
- C. Cutting of pipe shall be done with approved tools and by approved methods suitable for the pipe material. Pipe cutting methods that produce a smooth, square-cut end without damage to the pipe and that minimize airborne particles, shall be employed. Pipe cutting shall be performed using the recommendations of the manufacturer of the pipe materials being cut and according to the best trade practices.
- D. When cutting pipe or fittings, care shall be taken to prevent damage to linings and coatings. Damage to linings shall be cause for rejection of the complete Section. Damage to exterior coatings shall be corrected to original Specifications.

- E. Where pipe using a resilient gasket to affect the seal is cut, the cut pipe end shall be tapered at a 30-degree angle with the centerline of the pipe, and ground smooth, on the outside end to remove any sharp edges or burrs which might damage the gasket.
- F. Provide restrained joints meeting this specification and as recommended by the manufacturer. Connection shall be made in accordance with manufacturer's recommendations.
- G. After the bottom of trench has been excavated, the pipe bedding material will be installed in accordance with Section 31 2333, Trenching and Backfilling. Pipe shall then be installed strictly in accordance with the manufacturer's recommendations.
- H. After the pipe is laid, the bedding shall be continued above the pipe as specified in Section 31 2333, Trenching and Backfilling. Particular care shall be taken to assure filling and tamping spaces under, around and above the top of the pipe.
- I. A continuous and uniform bedding as specified in Section 31 2333, Trenching and Backfilling, shall be provided in the trench for all buried pipe.
- J. Unless otherwise specified, 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 end of the adjacent pipe section, the pipe shoved into position and brought to true alignment and secured. Adequate support shall be provided for all force main pipe.
- K. Backfill shall be as indicated on the Plans and as specified in Section 31 2333, Trenching and Backfilling.
- L. Fittings, plugs, adapters, and horizontal and vertical blocking shall be installed by CONTRACTOR as shown on the Plans; and the cost of the same shall be included in the unit price per lineal foot of force main.

3.05 Installation of Ductile Iron Pipe

- A. Push on joints shall be made by means of a compression type push-on resilient gasket. Gasket shall be pre-lubricated before installation using a lubricant recommended by the pipe manufacturer. Seated joint shall be identified by the visible mark on the spigot of the installed pipe section.
- B. When the temperature is above 60 degrees Fahrenheit (15 degrees Celsius), the spigot end of each pipe lead shall be forced tightly on the bell of the proceeding pipe. When the temperature is below 60 degrees Fahrenheit (15 degrees Celsius), the pipe shall be laid with the spigot end 1/16-inch (1 mm) from the face of the bell for expansion.
- C. Mechanical joints shall be made with bolts, molded resilient gasket and cast iron follower gland. Nuts shall be screwed up finger tight before using a wrench. The gland and rubber gasket shall be brought up evenly at all points around the bell flange and then torqued per the manufacturers recommendations.
- D. Exposed portions of bolts shall be covered with mastic.
- E. Flexible joint pipe shall be assembled, handled and installed in accordance with the printed recommendations which accompanies the pipe and is provided by the manufacturer of the piping materials being installed. Methods of handling and installation shall be acceptable to ENGINEER.

3.06 Installation of Concrete Pipe

- A. Concrete pipe and fittings shall be jointed by means of a resilient gasket and steel spigot ring. Resilient gasket shall be lubricated and installed to form a watertight joint between the bell and spigot of the pipe.
- B. Pipe shall be laid in accordance with the accepted tabulated laying schedule and the Plans.
- C. Short lengths of pipe (ten (10) feet or less) (3 m) specified under Article 1.05 of this Section shall be installed and evenly distributed along the line of the Work, if required.
- D. Bell of the pipe in place shall be cleaned and properly lubricated and pipe section installed. After the spigot is well entered into the bell and the gasket is fully compressed and brought to final shape, prior to driving the pipe home, check each gasket for proper position around the full circumference of the joint and complete installation.
- E. Provide cloth bands wired around each joint outside diameter and grout with Portland cement mortar grout. Completely fill the annular recess between the adjoining bell and spigot pipe ends. Annular spaces between pipe ends on the inside of joints of pipe 24 inches (600 mm) or more in diameter shall be filled with Portland cement mortar grout.

3.07 Installation of Polyvinyl Chloride Pipe

- A. Polyvinyl chloride pipe shall be laid with gasketed joints in complete accordance with the pipe manufacturers published instructions. Joints shall be sufficiently lubricated using the pipe manufacturers recommended lubricant.
- B. Gaskets for pipe joints shall be inserted with the painted edge facing the end of the bell. Each length of pipe shall be pushed home individually. Pipe shall be positioned so that the reference mark on the spigot end is in line with the bell end.
- C. When called for on the plans or in the specifications, tracer wire is to be installed along with the force main. Tracer wire is to be continuous from end to end and terminate at each structure in such a way and with a sufficient length of wire to allow for easy connection to utility tracing equipment. Wire shall be continuity tested after installation. Any wire which fails the continuity test shall be replaced.

3.08 Subaqueous Pipe

- A. Provide sections of pipe with joints for subaqueous trench installation as indicated on the Plans. Sections of pipe shall be assembled, bedded and backfilled before connecting to land lines. Sections shall be assembled on shore, then dragged or floated into position for installation. Joints of pipe lengths and connections to land lines shall be in accordance with manufacturer's recommendations.

3.09 Installation of Restrained Joints

- A. Restrained joints shall be provided where indicated on the plans. Joints shall be assembled in strict accordance with manufacturer's directions. Joints shall be fully extended after assembly.

3.10 Polyethylene Encasement

- A. Where called for on the plans, ductile iron fittings and pipe shall be encased in a polyethylene film tube. Polyethylene film tube shall be installed in accordance with ANSI/AWWA C105/A21.5, Method A. Method A consists of cutting the polyethylene tube two feet (600 mm) longer than the pipe to provide an overlap at the joints. Cost of the polyethylene encasement shall be incidental to the water main.

3.11 Anchors and Thrust Blocks

- A. Anchors, encasements and restraints shall be provided at the locations and dimensions as indicated on the Plans. Anchoring, encasement and restraint methods shall be as detailed. Bearings shall be as shown. Anchors, encasements and restraints shall rest on firm, stable, compacted bedding and shall be provided for standard and special fittings.

3.12 Valves

- A. Valves shall be installed to the grade, lines, levels and locations indicated on the Plans.
- B. Valve connections shall be as specified for the piping materials used. Valves shall be set with the stem plumb on permanent, firm foundations as indicated on the Plans.
- C. Where required, valves shall be supported with special supports as indicated on the Plans and as approved by ENGINEER. Valves shall be installed so as not to receive support from the connecting pipe. In no case shall valve installation be used to bring misaligned pipe into alignment.
- D. Provide all materials and install air release and vacuum release valve assemblies at locations indicated on the Plans. Include all valves, reducers, connections and other fittings necessary for installation. Fittings and joint materials shall be compatible to the force main piping material.

3.13 Valve Boxes

- A. Install valve boxes to the grade, lines, levels and locations indicated on the Plans. Valve boxes shall not transmit shock or stress to the valve and shall be set plumb with covers centered over operating nuts and flush with the indicated surface elevations. Valve boxes that shift or fill during backfilling shall be uncovered and reset.

3.14 Structures

- A. Construct structures to the grades, lines and levels indicated on the Plans and as specified. Structures shall be complete with concrete bases, reinforcing, frames, covers, adjustment rings, etc., as shown and as required for a complete installation. Construction of structures shall conform to the type of construction and dimensions indicated on the Plans and as described below.
 - 1. Brick Structures:
 - a. Prior to laying, all brick shall be thoroughly wetted and the surfaces allowed to dry only sufficiently to prevent slippage on the mortar.
 - b. Broken or chipped brick shall not be used on the faces of the structures.

- c. Brick shall be laid in neat, even consecutive courses with full and close mortar joints.
 - (1) Courses shall be level throughout, except as shown or otherwise required.
 - (2) Stagger joints in adjoining courses by one-half a brick as nearly as practicable.
 - (3) At least 1 course in every 7 shall be stretcher courses with intervening courses laid as headers.
 - (4) Length of brick closure pieces shall be not less than the width of 1 whole brick and, wherever practicable, closures as headers, shall be made from whole brick.
- d. Unless otherwise indicated, joints shall be not more than 1/2 inch (10 mm) thick and shall be of a uniform thickness throughout the structure. Joints shall be provided as indicated on the Plans.
 - (1) Exposed surfaces shall be true and smooth.
 - (2) Rake all joints to receive plaster coat.
- e. Prior to applying plaster coat, brick shall be thoroughly wetted with water and the surface allowed to dry sufficiently to effect proper bonding.

2. Block Structures:

- a. Construct concrete block structures in the locations and according to the details on the Plans.
 - (1) The first course of concrete blocks shall be placed on the prepared base or footings in a full bed of mortar.
 - (2) Mortar joints shall be full and close in all courses.
 - (3) Courses shall be level throughout.
 - (4) Stagger joints in adjoining courses by one-half the length of the block as nearly as practicable.
- b. Joints shall be uniform in thickness throughout the structures. Strike joints and properly point to provide true, smooth surfaces.

3. Precast Structures:

- a. Construct precast concrete structures as detailed on the Plans. Provide mortar joints struck smooth. Provide 2 to 4 courses of 3-inch (75 mm) brick at top of structure for future adjustment.
- b. Cement mortar plaster coat shall be applied to the exterior surfaces of all brick or block force main structures indicated on the Plans. Plaster coat shall be 1/2 inch (10 mm) thick and shall be applied to the outer surfaces of the structures.

- c. Provide and install to the elevations shown all cast iron covers, frames, adjusting rings, anchors, etc., indicated on the Plans and as required. Castings shall be set in a full bed of cement mortar 1/2-inch (10 mm) thick minimum. Mortar joints shall be struck smooth.
- d. Install steps on 16-inch (400 mm) centers (minimum) for structures of types and in locations indicated on the Plans.
- e. Pipe placed in structures for inlet or outlet connections shall extend through the walls and beyond the outside wall surfaces a sufficient distance to allow for complete connections. Openings between pipes and walls shall be sealed with a full bed of cement mortar. Pipe shall be supported by concrete supports.

3.15 Hydrostatic Testing

- A. After the pipe has been laid and backfilled, the pipe shall be hydrostatically tested for leakage.
- B. CONTRACTOR shall furnish the pump, pipe connection, blow-off valves and all other necessary apparatus including gages and meters and personnel necessary for conducting the test.
- C. Before applying the test pressure, all air shall be expelled from the pipe. If necessary, threaded taps shall be made at the points of higher elevation and then closed with brass plugs.
- D. Faulty pipe fittings, valves or other accessories which permit leaks during testing shall be replaced by CONTRACTOR with sound material and the test shall be repeated until specified requirements are met.
- E. When practicable, tests shall be made on sections between valves, or sections not exceeding 2,000 feet (610 m) in length. Dead ends, bends and other fittings shall have a firm foundation and be securely blocked against the trench walls before testing or completing the backfill as specified.
- F. Full test pressure shall be held for no less than one (1) hour or longer as necessary to permit thorough examination of all exposed joints in the section of main being tested. Test pressure shall be maintained at 150 psi (1000 kPa) for force mains.
- G. Leakage shall be measured by the quantity of water pumped into the pipe to maintain test pressure during test period. Leaks shall be located and repaired until the test meets the the minimum requirements stated herein. Maximum permissible leakage of force main shall not exceed the following:

Force Main Diameter inches (mm)	Allowable Leakage gallons/1,000 feet/hour (liters/0.5 km/hour)
4 (100) or less	0.5 (3.0)
6 (150)	0.75 (4.5)
8 (200)	1.00 (6.0)
10 (250)	1.25 (8.0)
12 (300)	1.50 (9.0)
14 (350)	1.75 (11.0)
16 (400)	2.00 (12.5)
18 (450)	2.25 (14.0)

Force Main Diameter inches (mm)	Allowable Leakage gallons/1,000 feet/hour (liters/0.5 km/hour)
20 (500)	2.50 (15.5)
22 (550)	2.75 (17.0)
24 (600)	3.00 (18.5)

3.16 Water for Testing

- A. Water for testing shall be obtained from a water source approved by ENGINEER. CONTRACTOR shall provide all water required at his own expense and shall make necessary arrangements with the authority which controls the source of water system and shall be governed in his use of water by all rules and regulations imposed thereon by said authority.
- B. CONTRACTOR shall provide and remove temporary connections between the source water system and the mains constructed under this Contract.
- C. Temporary connections shall meet the approval of ENGINEER, the authority controlling the source water system and authorities having jurisdiction.
- D. Water for testing shall be removed from the force main by pumping to waste. Water discharge shall be controlled adequately to protect any surface water resource or adjacent property from potential environmental damage or from creation of hazard to traffic.

3.17 Flushing Force Main

- A. Should the force main flows not meet design requirements, CONTRACTOR shall flush the force main at no additional cost to OWNER.
 - 1. Flushing shall be done using the "poly-pig" method of flushing and CONTRACTOR shall furnish foam "poly-pig" swabs to be used.
 - 2. Prior to pigging and flushing, the force main must be charged with water.
 - 3. CONTRACTOR shall insert "poly-pig" swab in the end of the new main nearest the pump station (or where shown on the Plans).
 - 4. The swab shall be passed through the new main using water pressure.
 - 5. The swab shall be recovered at the end of the main or cleanout.

End of Section

Section 33 4100

Storm Utility Drainage Piping

Part 1 General

1.01 Scope of Work

- A. This Section includes storm sewer Work indicated on the Plans complete with pipes, joints, structures, pipe bedding, final inspection and appurtenances.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200: Unit Prices
- B. Section 04 0511: Mortaring and Grouting
- C. Section 31 2319: Dewatering
- D. Section 31 2316: Structural Excavation and Backfill
- E. Section 31 2333: Trenching and Backfilling

1.03 Reference Standards

- A. Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. ANSI - American National Standard Institute
 - 2. ASTM - ASTM International
 - 3. AASHTO - American Association of State Highway Transportation Officials
 - 4. MDOT - Michigan Department of Transportation, Standard Specifications for Construction, latest edition
 - 5. NCPI - National Clay Pipe Institute

1.04 Source Quality Control

- A. Laboratory test not less than 1 percent, with a minimum of 3 pieces each size, material and class of gravity pipe required in the Work.

1.05 Submittals

- A. Submit a complete field report of the location of all wye openings and sump pump discharge leads to ENGINEER at the end of each sewer section of the Project or on the last day of each week, whichever occurs first.
- B. Submit two (2) copies of the laboratory test reports required per Article 1.04 of this Section to ENGINEER.
- C. Provide manufacturer's data and installation instructions for precast manhole and vault sections, joint connections, water stops, gaskets, corrosion protection system, flexible pipe joints, chimney seals, manhole and vault castings, and other pertinent information for precast and cast-in-place manholes and vaults.

- D. Submit shop drawings and design information for all precast concrete box sections, including but not limited to joint connections, water stops, gaskets, corrosion protection system, and other pertinent information.
- E. Manufacturers Certification: Certify that all products furnished meet or exceed the specified requirements, including worst case depth loadings for this project.
- F. Calculations: Submit calculations for review sealed and signed by a registered Professional Structural Engineer in the State of Michigan. Include structural, depth of bury, buoyancy, and all other information necessary to determine adequacy of the item.

1.06 Storage of Materials

- A. Piping material shall not be stacked higher than four (4) feet (1.2 m) or as recommended by the manufacturer, whichever is lowest. Suitable racks, chairs, and other supports shall be provided to protect preformed pipe mating surfaces from damage. Store bottom tiers off the ground, alternate tiers and chock tier ends.
- B. Jointing and sealing materials used in the storm sewer system shall be protected from sunlight and stored in as cool and clean a place as practicable until ready for application.

1.07 Handling of Material

- A. Load and unload materials using suitable approved equipment. Material shall not be dropped, bumped or allowed to impact against itself. Damaged material shall be rejected by ENGINEER.
- B. Lifting devices shall be suited to the Work and shall protect surfaces from damage.

Part 2 Products

2.01 Materials

- A. It is the intent of the Articles in Part 2 of this specification section is to specify in detail the various types of sewer pipe, joints, manholes, etc. which have been indicated throughout the Plans and Specifications.
- B. These Articles shall not be construed as allowing any alternate type of material to that which is indicated on the Plans or elsewhere in the Specifications.

2.02 Clay Pipe

- A. Clay pipe shall conform to ASTM C700, extra strength vitrified clay pipe.
- B. Premium joints shall be compression type joints conforming to ASTM C425.
- C. When not specified, joints shall be made with cold applied pipe joint sealer. See Article 2.07 for requirements for cold applied pipe joint sealer.

2.03 Non-Reinforced Concrete Pipe Systems

- A. Pipe shall conform to ASTM C14 Class III nonreinforced concrete sewer pipe.
- B. When not specified, pipe joints shall be made with cold applied pipe joint sealer. See Article 2.07 for requirements for joints.

2.04 Reinforced Concrete Pipe

- A. Reinforced concrete pipe shall conform to ASTM C76. Twelve (12) inch thru 30-inch (300 mm thru 750 mm) diameter pipe shall be Class II thru V, Wall B or Wall C, circular reinforced. Thirty-six (36) inch through 108-inch (900 mm thru 2700 mm) diameter pipe shall be Class I through V, Wall B or Wall C, circular reinforced or elliptical reinforced.
- B. When elliptical reinforcement is used, the following method of indexing the steel and the pipe barrel shall be used.
- C. A dummy lift pin form shall be set in the outer pipe wall form projecting into the pipe wall a minimum of 1-3/4 inches (45 mm) and a maximum of 2-1/4 inches (55 mm). An additional spacer chair shall be welded to the elliptical steel cage at the proper location so as to engage the dummy lift pin form during the pipe casting operation.
- D. It is the intent of the spacer chair and dummy lift pin arrangement to provide a means of assuring the final position of the elliptical steel cage within the barrel of the pipe and, further, for providing a means of indexing the pipe in the field to assume proper placement of the pipe.
- E. Prior to shipment of the elliptically reinforced pipe, they shall be striped along the inside top with a minimum 1-inch (25 mm) wide indelible marker so that final inspection of the pipe orientation can be made following completion of the installation.
- F. For circular pipe 114 inches (2850 mm) or larger in diameter, the design information in accordance with Section 6 of ASTM C76, shall be submitted to ENGINEER for approval, prior to fabrication.
- G. The design of all pipes shall meet the d-load requirements for the class of pipe indicated on the Plans.
- H. When not specified, pipe joints shall be made with cold applied pipe joint sealer. See Article 2.07 for requirements for joints.

2.05 Reinforced Concrete Elliptical Pipe

- A. Reinforced concrete elliptical pipe shall conform to ASTM C507.
- B. When not specified, pipe joints shall be made with cold applied pipe joint sealer. See Article 2.07 for requirements for joints.

2.06 Precast Concrete Box Section

- A. Precast concrete box sections shall meet the requirements of ASTM C1433. Unless specified otherwise, CONTRACTOR shall use the same design conditions as exist at the time of construction or as planned for future development.

2.07 Joints for Concrete or Clay Pipe

- A. Sealed Joints:
 - 1. When not specified, pipe joints shall be made with cold applied pipe joint sealer. Cold-applied pipe joint sealer shall conform to MDOT Section 909.09.

The bituminous material shall be of such consistency that it may be spread on the joints with a trowel when the temperature of the air is between 20 degrees and 100 degrees Fahrenheit (-10 degrees and 40 degrees Celsius). Bituminous material shall adhere to the pipe so as to make a watertight seal and shall not flow, crack or become brittle when exposed to the atmosphere.

B. Premium Joints:

1. Premium joints for circular pipe shall conform to ASTM C443 limited as follows: Section 5.1 of C443, "Physical Requirements for Gaskets," shall be replaced with Section 6.9 of C361, "Rubber Gaskets." Also, Section 5 of C443 shall be limited to a modified grooved tongue to receive a rubber gasket.
2. Premium joints for elliptical pipe shall conform to ASTM C877, external sealing bands for non-circular concrete pipe. Width of the sealing bands shall be at least equal to twice the depth of the groove. For modified bell tongue and groove pipe, use the next larger gasket. Length of the sealing bands shall be equal to the outside circumference of the pipe at its largest diameter plus an amount equal to the width of the gasket to be used.
3. Only lubricant, as supplied by the pipe manufacturer, shall be used on the groove and on the tongue in making up joints, and the joints shall be coupled in accordance with the pipe manufacturer's requirement.

- C. Inside annular space of concrete pipe 36-inch (900 mm) diameter (or equivalent) and larger shall have the inside annular space filled with cement mortar and troweled flush. Mortar shall consist of 1-part Portland cement and two (2) parts of plaster sand. Mortar for inside joints shall be mixed with only enough water for "dry packing."

2.08 Corrugated Metal Pipe

A. Galvanized Corrugated Metal Pipe:

1. Corrugated galvanized steel pipe with circular cross section and corrugated galvanized steel pipe with pipe-arch shape shall conform to the requirements of AASHTO M36, and as specified in MDOT Section 909.05. Helical corrugated pipe shall have a minimum of two (2) circumferential corrugations rerolled on each end of each section of pipe.

B. Polymeric Coated Corrugated Galvanized Steel Pipe:

1. Polymeric coated corrugated galvanized steel pipe with circular cross section and polymeric coated corrugated galvanized steel pipe with pipe-arch shape shall conform to the requirements of AASHTO M245, and as specified in MDOT Section 909.05. Helical corrugated pipe shall have a minimum of two (2) circumferential corrugations re-rolled on each end of each section of pipe.

C. Aluminized Type 2 Corrugated Metal Pipe:

1. Type 2 aluminized corrugated steel pipe with circular cross section and corrugated steel pipe with pipe-arch shape shall conform to the requirements of AASHTO M36, AASHTO M274, Type 2 and as specified in MDOT Section 909.05. Helical corrugated pipe shall have a minimum of two (2) circumferential corrugations re-rolled on each end of each section.

D. Corrugated Aluminum Alloy Pipe:

1. Corrugated aluminum alloy pipe with circular cross section and corrugated aluminum alloy pipe with arch-pipe shape shall conform to the requirements of AASHTO M196 and MDOT Section 909.05.

E. Joints for Corrugated Metal Pipe:

1. Joints for corrugated metal pipe shall be made by use of coupling bands. Coupling bands shall be of the same material as specified for the pipe and shall prevent infiltration of the side fill material. Coupling bands shall be corrugated to match the corrugations of the pipe to be jointed and shall include two (2) "O" ring neoprene gaskets for each joint. Dimple bands shall not be used.
2. Joints shall be wrapped with a 3 foot (1 m) wide geotextile filter fabric centered on the joint.
3. When called for in the Contract Documents, joints shall have bell and spigot coupling system and rubber gasketed joint.

2.09 Dual Wall Corrugated PVC Pipe – Smooth Interior

- A. Pipe shall be a single extrusion of PVC with smooth interior and corrugated outer walls. Corrugated outer profile shall be annular and seamless. Pipe and fittings shall be in accordance with ASTM F949. Joints shall be bell and spigot type with an elastomeric gasket meeting the requirements of ASTM F477 and be suitable for storm sewer service.
- B. Wyes or tees shall be a molded wye or tee fitting per ASTM F949, with gasketed joints on each end suitable for directly inserting in the mainline pipe. Branch connection fitting shall be a gasketed joint suitable for the house lead pipe specified. Saddle connections are not allowed.
- C. Acceptable manufacturers of Dual wall corrugated pipe include Contech A2000, Uponor ETI Ultra-Corr or ENGINEER approved equal.

2.10 Corrugated Polyethylene Pipe

A. Smooth-Lined Corrugated Polyethylene Pipe:

1. Smooth lined corrugated polyethylene pipe shall meet the requirements of MDOT section 909.06 and AASHTO M252, Type S for sizes 4" to 10" diameter, and AASHTO M294 Type S for 12" to 48" diameter.
2. Fittings shall conform to the corresponding pipe specification and be constructed of the same material classification as the pipe. Fittings shall be welded on the interior and exterior at all junctions.
3. Joints shall be bell & spigot type with rubber gaskets on both sides of the joint conforming to MDOT section 909.03 and ASTM F477. Split collar couplers are not allowed. Joints shall be watertight meeting the performance requirements of ASTM D3212.

B. Corrugated Plastic Edge Drain / Underdrains:

1. Corrugated plastic tubing for edge drains or underdrains shall meet the requirements of AASHTO M252 for polyethylene tubing. Pipe shall be wrapped in a Geotextile Pipe Wrap per MDOT Section 910.03.A.

2.11 Smooth Plastic Pipe

- A. Smooth plastic pipe for underdrains shall be polyvinyl chloride PVC meeting the requirements of AASHTO M278. Pipe shall be wrapped in a Geotextile Pipe Wrap per MDOT Section 910.03.A.

2.12 Structural Plates for Field Assembly of Pipe, Pipe-Arches, and Arches

- 2.13** Plates, bolts and nuts to be used in field assembled circular pipe, pipe-arches and arches shall meet all applicable requirements of AASHTO M167 and as specified in MDOT Section 909. End Sections

- A. Precast concrete end section shall conform to ASTM C76, Class II and as specified in MDOT Section 909.04. Joint for connection to pipe shall be by means of a standard tongue and groove with cold-applied pipe joint sealer. See Article 2.07 of this Section for requirements for the cold-applied pipe joint sealer.
- B. Metal end sections shall conform to MDOT 909.05. See Article 2.08 for requirements for joints.

2.14 Storm Structures

- A. Materials for storm sewer structures shall conform to the requirements indicated on the Plans and as specified below.
 1. Concrete Brick:
 - a. Concrete brick shall be ASTM C55, Grade S-II, solid units of nominal 3-inch (75 mm) thickness.
 2. Concrete Block:
 - a. Block shall conform to ASTM C139, manufactured of Portland cement conforming to ASTM C150, Type II.
 - b. Blocks shall be solid curved blocks with the inside and outside surfaces parallel and curved to the required radii.
 - c. Blocks shall have a groove or other approved type of joint at the ends.
 - d. Blocks intended for use in the cones or tops of manholes shall have such shape as may be required to form the structure as indicated on the Plans.
 3. Precast Concrete:
 - a. Precast concrete manhole, flat top slabs, risers, cone, bases, grade rings, transition sections and bottom sections shall conform to ASTM C478, and shall be circular with circular reinforcement.

- b. For depths greater than 32-feet, the manhole shall be designed for the earth loading at the design depth of bury with a factor of safety of 1.5. Base slab shall be eight (8) inches (200 mm) thick for depths up to 25 feet (7.5 m) and 12 inches (300 mm) thick for depths greater than 25 feet (7.5 m).
 - c. Transition sections, reducers and flat top slabs shall be designed for the earth loading at the design depth of bury with a factor of safety of 1.5.
 - d. Precast concrete manhole tee units shall conform to ASTM C76, Class IV and shall be circular with circular reinforcement. Shop Drawings shall be provided for all manhole tees.
 - e. Joints on the precast manhole tee shall be the same as the joints on the storm sewer section.
- 4. Manhole Steps:
 - a. Cast iron manhole steps shall conform to ASTM A48, Class 30, gray iron with a minimum cross section dimension of 1-inch (25 mm) in any direction.
 - b. Steel reinforced plastic steps shall be of suitably approved co-polymer polypropylene conforming to ASTM D4101, PP0344B33534Z02 with 1/2 inch (12 mm) minimum diameter deformed reinforcing bar conforming to ASTM A615, Grade 60.
 - c. Manhole steps shall be of the type and size indicated on the Plans and shall comply with applicable occupational safety and health standards. Manhole steps shall be installed at locations indicated on the Plans.
- 5. Frames and Covers:
 - a. Frames and covers for manholes, catch basins, and inlets shall conform to ASTM A48, Class 30, gray iron and shall be of the types and sizes as indicated on the Plans.
 - b. Castings shall be neatly made and free from cracks, holes and other defects. Surfaces of casting shall be ground to assure proper fit and to prevent rocking.

2.15 Concrete

- A. In accordance with MDOT Section 701, use Grade S2; 3,500 psi (24 MPa) strength; Type IA cement; 6.0 sacks cement per cubic yard (335 kg/m³); 6A coarse aggregate; 2NS fine aggregate; 6.5% ± 1.5% air content; 3-inch (75 mm) maximum slump; no admixtures without ENGINEER's approval.

2.16 Concrete Reinforcement

- A. In accordance with MDOT Section 905, use ASTM A615, Grade 60 for bars and ASTM A185 for welded wire fabric.

Part 3 Execution

3.01 Verification of Excavation and Bedding

- A. Prior to the installation of any storm sewer piping, structures, or materials, examine trenches and other excavations for the proper grades, lines, levels and clearances required to receive the new Work. Ascertain that excavation bottoms, compacted subgrades and pipe bedding are adequate to receive the storm sewer materials to be installed. Correct defects and deficiencies before proceeding with the Work.

3.02 Existing Storm Sewers and Drains

- A. Expose the existing storm sewer and structures to which the new Work is to be connected and notify ENGINEER of same. ENGINEER will verify the vertical and horizontal locations of the existing system and shall inform CONTRACTOR as to the necessary adjustments required to align the new storm sewer Work with the existing system.

3.03 Preparation

- A. Outside surface of the spigot end and the inside surface of the bell end of the pipe shall be cleaned and free of any foreign materials, other than the sealant recommended by the manufacturer, prior to installation.
- B. Pipe, frames, covers, accessories, and appurtenances shall be examined carefully for damage and other defects immediately prior to installation. Defective or damaged material shall be rejected and removed from the Project by CONTRACTOR.

3.04 Installation - General

- A. Each section of pipe, when placed to grade and line, shall have firm bearing on the trench bedding throughout its length.
- B. Cutting of pipe shall be done with approved tools and by approved methods suitable for the pipe material.
 - 1. Pipe cutting methods that produce a smooth, square-cut end without damage to the pipe and that minimize air-borne particles, shall be employed.
 - 2. Pipe cutting shall be performed using the recommendations of the manufacturer of the type of the pipe materials being cut and according to the best trade practices.
 - 3. When cutting pipe, care shall be taken to prevent damage to the interior and exterior surfaces.
 - 4. Damage to either shall be cause for rejection of a complete section of pipe.
- C. During the preparation of the pipe bedding and until the trench has been satisfactorily backfilled, the trench shall be kept free of water.
 - 1. A dewatering system, in accordance with Section 31 2319, Dewatering, shall be provided and maintained by CONTRACTOR. Dewatering system shall remain in operation until the trench is backfilled.
- D. Backfill shall be as indicated on the Plans and as specified in Section 31 2333, Trenching and Backfilling.

3.05 Pipe Laying

- A. Installation of pipe shall conform to ASTM C12, and as recommended by the pipe manufacturer.
- B. Pipe shall be protected during handling against impact shocks and free fall. Hooks shall not be permitted to come in contact with pre-molded joint surfaces.
- C. Pipes having pre-molded joint rings or attached couplings shall be handled so that no weight, including the weight of the pipe itself, will bear on or be supported by the jointing material. Care shall be taken to avoid dragging any pipe on the ground or allowing it to be damaged by contact with gravel, crushed stone, or other hard objects.
 - 1. Pipe shall be laid to the line and grade called for on the Plans.
 - 2. Each pipe as laid, shall be checked by CONTRACTOR with line and grade pole or laser system to insure that this result is obtained.
 - 3. When employing a laser system, CONTRACTOR shall have an independent and alternate means of checking the line and grade.
 - 4. Finished work shall be straight and shall be sighted through between manholes.
- D. Construction shall begin at the outlet end and proceed upgrade with spigot ends pointing in direction of flow. Bell holes shall be excavated so that the full length of the barrel will bear uniformly on the bedding material.
- E. Lubricants, primers or adhesives as recommended by the pipe or joint manufacturer shall be used immediately prior to jointing.
- F. Pipe shall be centered in the bells or grooves and pushed tight together to form a smooth and continuous invert. After laying of pipe, care shall be taken so as not to disturb its line and grade. Pipes found off grade or out of line shall be re-laid properly by CONTRACTOR.
- G. Mechanical means shall be used for pulling home pipe where manual means will not result in pushing and holding the pipe home. Mechanical means shall consist of a cable placed inside of the pipe with a suitable winch, jack, or come along for pulling the pipe home and holding the pipe in position.
- H. Circular concrete pipe with elliptical reinforcement shall be installed with the lift holes to the top of the pipe. Manufacturer's marks designating the top and bottom of the pipe shall not be more than five degrees from the vertical plane through the longitudinal axis of the pipe. After the pipe is installed, the lift holes shall be sealed with suitable concrete plugs.
- I. Type "HE" elliptical pipe shall be installed with the longer axis placed horizontally within a tolerance of plus or minus five degrees ($\pm 5^\circ$).
- J. Type "VE" elliptical pipe shall be installed with the longer axis placed vertically within a tolerance of plus or minus five degrees ($\pm 5^\circ$).

3.06 Pipe Bedding

- A. After the bottom of trench has been excavated the pipe bedding material will be installed in accordance with Section 31 2333, Trenching and Backfilling. Pipe shall then be installed strictly in accordance with the manufacturer's recommendations. After the pipe is laid, the bedding shall be continued above the pipe as specified in Section 31 2333, Trenching and Backfilling. Particular care shall be taken to assure filling and tamping spaces under, around and above the top of the pipe.
- B. A continuous and uniform bedding as specified in Section 31 2333, Trenching and Backfilling, shall be provided in the trench for buried pipe.

3.07 Underdrains

- A. Pipe shall be laid in close conformity with the lines or grades shown on the Plans or established by ENGINEER. The upgrade ends of all underdrains shall be closed with suitable plugs to prevent entry of soil or other foreign material.
- B. Perforated pipe shall be laid with the perforations down.
- C. Underdrains shall be bedded in MDOT open graded drainage course material. Bedding shall have a minimum thickness beneath the pipe of four (4) inches (100 mm), a minimum width of six (6) inches (150 mm) on each side of the pipe and extend to a level not less than 12 inches (300 mm) above the top of the pipe.
- D. Bedding shall be placed equally on both sides of the underdrain at the same time. Staking or other methods to restrain the pipe may be necessary during the backfilling operation to maintain the line and grade of the underdrain.
- E. Rodent screens and outlet endings are required for all underdrains which terminate in a ditch or swale.

3.08 Storm Structures

- A. Construct storm sewer manholes, catch basins, inlets and other structures to the grades, lines and levels indicated on the Plans and as specified. Structures shall be complete with concrete bases, reinforcing, frames, covers, adjustment bricks, etc., as shown and as required for a complete installation. Storm sewer structures shall conform to the type of material and dimensions indicated on the Plans.
- B. Cast-in-place structures shall be constructed in accordance with Section 03 3000, Cast-In-Place Concrete.
- C. Block Structures:
 - 1. Construct concrete block structures in the locations and according to the details on the Plans. The first course of concrete blocks shall be placed on the prepared base or footings in a full bed of mortar. Mortar joints shall be full and close in all courses. Courses shall be level throughout. Stagger joints in adjoining courses by one-half the length of the block as nearly as practicable. Joints shall be uniform in thickness throughout the structures. Strike all joints and properly point to provide true, smooth surfaces.
- D. Precast Concrete Structures:

1. Construct precast concrete structures as detailed on the Plans. Provide mortar joints struck smooth. Provide three (3) to five (5) courses of 8-inch (200 mm) brick or concrete grade rings at top of structure for future adjustment of castings.
- E. A cement mortar plaster coat shall be applied to the exterior surfaces of the brick and block sections of all storm structures as indicated on the Plans. Plaster coat shall be 1/2 inch (10 mm) thick.
- F. Provide and install all frames and covers to the elevations indicated on the Plans. Castings shall be set in a full bed of cement mortar 1/2 inch (10 mm) thick, minimum. Mortar joints shall be struck smooth.
- G. Steps shall be installed at the plant by the manufacturer of precast units. Field install steps for brick, block, or cast in place structures of the types and in the locations indicated on the Plans.
- H. Pipe up to 42 inches (1050 mm) in diameter shall be connected to storm structures using a grouted joint, as indicated on the Plans. The pipe shall be properly supported, so that any settlement will not disturb the connection.
- I. For pipe, 48 inches (1200 mm) in diameter or larger, the pipe shall be installed as an integral part of the manhole which shall be constructed of 3,500 psi (24 MPa) concrete and reinforcing, as indicated on the Plans.
- J. Manhole tees, as indicated on the Plans, may be used for pipe 42 inches (1050 mm) in diameter or larger. Connection to manhole tees shall be made using tees and pipe having the same type of joint. The pipe and tee shall be properly supported with concrete as indicated on the Plans.
- K. Sump shall be provided, as indicated on the Plans, in all catch basins and storm manholes having outlets of 18 inches (450 mm) in diameter or less.
- L. Flow channels shall be constructed in all structures not requiring a sump and shall be constructed as indicated on the Plans.

3.09 Field Quality Control

- A. After all the pipe and structures have been laid, constructed and backfilled, the system shall be final inspected. The sewer system shall be ready for the final inspection within two (2) weeks after the completion of each 2,000-foot (600 m) section of sewer installed.
- B. Final inspection shall consist of a visible and audible check of the sewers and structures to ascertain that the steps have been placed, lift holes jointed, the channeling of the manhole bottoms completed, visible or audible leaks stopped, pipe has been placed straight and true to the proper slopes and elevations, the required brick courses for adjustment, the frame and cover properly installed, the required end section installed, trenches and structures backfilled in a workmanlike manner and that the system has been thoroughly cleaned.
- C. The final inspection shall be considered complete when all the repairs have been made.

3.10 Deflection Test for Plastic Pipe

- A. Plastic pipe shall be tested for deflection, but no sooner than 30 days following the backfilling of the pipe.

- B. Maximum allowable deflection (reduction in vertical inside diameter) shall be five (5) percent.
- C. Locations with excessive deflection shall be excavated and repaired by re-bedding and/or replacement of the pipe.
- D. Optional devices for testing include a deflectometer, calibrated television or photography, or a properly sized "go, no-go" mandrel or sewer ball. Mandrel shall have a minimum of nine (9) legs.

3.11 Remove Storm Sewer

- A. Excavate and remove the existing storm sewer where indicated on the plans.
- B. Bulkhead the opening in storm sewers or structures where the existing storm sewer has been removed.
- C. Where removal of existing storm sewer is occurring in essentially the same location as a new sewer or structure, the removal of the existing sewer is incidental to the project.

3.12 Remove Culverts

- A. Excavate and remove culverts where indicated on the plans. Backfill the completed work as specified under "Backfilling Trenches" in Section 31 2333, Trenching and Backfilling.

3.13 Remove Structure

- A. Excavate and remove structures where indicated on the plans. Bulkhead the ends of any sewers remaining in place. Backfill the completed work as specified under "Backfilling Trenches" in Section 31 2333, Trenching and Backfilling. Removal of existing storm structures is incidental to the project if a new structure or sewer is being constructed in essentially the same location.

3.14 Remove and Replace Storm Sewer

- A. Remove and replace storm sewer shall consist of the complete removal and disposal of the existing sewer and replacement with the size and type of sewer as called for on the plans or specified. All materials and installation shall be in accordance with the requirements of this section and Section 31 2333, Trenching and Backfilling, as applicable.

3.15 Remove and Replace Storm Structure

- A. Remove and replace storm structure shall consist of the complete removal and disposal of the existing structure and replacement with the size and type of structure as called for on the plans or specified. Materials and installation shall be in accordance with the requirements of this section and Section 31 2333, Trenching and Backfilling, as applicable.

End of Section

Division 40
Process Interconnections

Section 40 0505 Exposed Piping Installation – General

Part 1 General

1.01 Work Included

- A. This section of these specifications is intended to outline the basic construction methods and materials to be used for the installation of all piping and equipment systems, and such other work and materials that shall be used to meet the Contract requirements of the mechanical systems for the project to the best accepted level of practice, to meet the requirements of governing codes and as approved by OWNER.

1.02 Note

- A. This section is comprised of standards of construction and materials for the Mechanical Division of these specifications. CONTRACTOR shall refer to the detailed sections of the Mechanical Division of these specifications and to the drawings to ascertain which systems he is 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 particular sections and shall apply.

1.03 Coordination

- A. Before proceeding with installation of piping, etc. CONTRACTOR shall inspect the contract documents and determine that the location of the work does not interfere with other work. In case of interference, OWNER shall be notified in writing. OWNER will then determine the resolution of the conflict and his decision shall be binding.

Part 2 Products

2.01 Piping

- A. In the description of piping materials, the following abbreviations are used:

T & C	Thread & Couple
Blk	Black
stl	steel
M.I.	malleable iron
F.S.	forged steel
C.S.	cast steel
C.I.	cast iron
D.I.	ductile iron
scrd	screwed
thk	thick
galv	galvanized
flgd	flanged
sched.	schedule
- B. ratings in this description of piping materials shall be taken to mean American National Standard Institute ratings.

2.02 Bolts, Studs and Nuts

- A. Steel bolts, studs and nuts shall be in conformity with the current Tentative Specifications for Low Carbon Steel Externally and Internally Threaded Standard Fasteners, ASTM Designation: A-307, Grade B.
- B. Carbon steel bolts and nuts used for joining flanged pipe shall be galvanized or cadmium plated unless otherwise called for. All bolts shall be coated with anti-seize compound prior to assembly.
- C. Sleeves for anchor bolts shall be made of Schedule 40 steel pipe and shall be at least 1/2 inch larger in inside diameter than the anchor bolt.

2.03 Anchors

- A. Anchors shall be provided to rigidly and securely fasten piping to building construction where shown or as required.
- B. Anchors shall be located in such a manner that they will not distort any part of the building as the result of expansion and contraction of piping.
- C. Anchors may be angle iron, inserts, U-bolts and anchor chairs, or a combination of the above. Anchors may also be the screwed coupling type.

2.04 Inserts and Anchor Bolts

- A. Piping which must be supported from concrete walls, ceiling slabs, columns and other building masonry (except floors) shall be attached by means of approved inserts embedded in concrete or masonry, unless otherwise noted.
- B. Inserts shall be continuous slotted inserts approximately 1-5/8" wide, 1-3/8" deep by length as required, roll formed not less than 12 gage steel into slotted "U" conformation for 5/8 in. bolt size unless otherwise indicated, with anchors spaced on not more than 6 in. centers, plates and bolts and nuts as required by conditions, shall be provided. Slotted inserts shall be Gateway Erectors, Inc., Type "G", Hohman and Barnard Type CH05, or equal.
- C. Piping to be secured to floor slabs or concrete bases shall be supported with approved prefabricated supports anchored to the floor or cast in place concrete supports.
- D. Drilled expansive anchor bolts are permissible provided that electric hammers are used, and that the specific hammers have been approved for the purpose by the OWNER. Anchor bolts shall be Wejit, Parabolts, Kwikbolt, or equal. All bolts shall be stainless steel coated with anti-seize compound prior to assembly.

2.05 Pressure Gauges

- A. Pressure gauges shall be provided and installed on the suction and discharge lines of each pump. Range for the gauges shall be 0-50 psi on the discharge and 15-0-15 psi on the suction. Gauges shall be a minimum of 4 inches in diameter and shall be glycerin filled. Rated accuracy shall be one (1%) percent of full-scale reading. Gauges shall be Ashcroft or equal.

- B. Gauges shall be mounted firmly secured to pumps or piping. Gauge installations shall be complete with all hoses and fittings and shall include a shutoff valve and sludge/solids isolater installed in each gauge line at the point of connection to suction and discharge pipes. Isolater shall be Red Valve Series 742 or equal.

2.06 Pipe Guides and Spacing

- A. Approved pipe alignment guides shall be provided in the piping adjacent to and on each side of all pipe expansion joints and loops, in order to control the pipe movement in true perpendicular alignment to the expansion joints and loops.
- B. First guides at 4 pipe diameters on each side of device.
- C. Second guides at 14 pipe diameters beyond first guide.
- D. Intermediate guides per standard of Expansion Joint Manufacturers Association (E.J.M.A.).

Part 3 Execution

3.01 Excavation and Backfilling - Underground Piping

- A. CONTRACTOR shall perform all necessary excavating, trenching, backfilling, shoring and restoring, in connection with his work as specified herein. Excavations shall conform to the invert dimensions designated on the drawings or as required by field conditions and/or directed by OWNER.
- B. On excavations which occur near and below any foundation footings, the backfilling materials shall consist of concrete poured up to the level of the bottom of footing of the same strength as the concrete in the footings.
- C. Crossing Protection: Adequate temporary crossovers for pedestrian and vehicular traffic shall be provided including guard rails, lamps and flags, as required by agencies having jurisdiction and as directed by OWNER. All items shall be removed when necessity for such protection ceases.

3.02 Underground Piping Installation

- A. No piping shall be installed in filled or disturbed earth until the earth has been compacted to properly support general construction, as specified in the backfill requirements.
- B. All trenches shall be dry and clean when pipe is being laid.
- C. Pipe and fittings shall be inspected for defects prior to being lowered into the trench and shall be cleaned both inside of the bell and outside of the spigot.
- D. All pipe lines shall be laid straight and in true alignment with the grade and location established on the drawings, or as directed by OWNER.
- E. Pipes passing through walls below grade and passing through sleeves shall be made watertight by sealing as specified or in an approved manner.

- F. In some cases, pipe shall pass through boxed out areas in slabs or walls, as shown on the Drawings.
- G. Pipes or tubing passing through or under building grade beams shall be installed in a sleeve giving 4 in. clearance to prevent possible damage from settling of the building.

3.03 Flushing Underground Systems

- A. Before backfilling and before connecting aboveground systems to the underground connections, all pipe, fittings, valves, etc., shall be cleaned of core sand, scale and other foreign matter.
- B. Underground piping shall be flushed with water at a velocity of at least 6 ft. per second for a fifteen (15) minute period, or until all dirt and debris are thoroughly flushed out.

3.04 Aboveground Piping Installation-All Services

A. General

1. Pipe lines aboveground shall be run parallel with the lines of the building unless otherwise shown or noted on the drawings. All horizontal runs of piping shall be kept as high as possible so as to provide maximum head room. Vertical lines shall be kept as close to the columns or walls as possible. Pipe lines shall be run so as not to interfere with ducts, conduits or apparatus 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 drawings or required as essential to an approved installation.
2. All pipe ends shall be reamed. Care shall be taken at all times to prevent foreign material from entering any pipe.
3. All threaded coupling shall be made using an approved teflon tape on the male end. Care shall be taken to prevent the tape from reaching the pipe interior.
4. All horizontal lines shall pitch to low points to provide for complete drainage of each system. Pitch, unless otherwise shown on the drawings shall be not less than 1 inch in 40 feet against direction of flow. Air vents shall be installed at all high points and at locations where air may pocket on all water lines. Air vents shall be drained to sewers or suitable receivers. Hot water heating, gas and air lines shall pitch as stated, but in direction of flow.
5. All gaseous piping connections to equipment shall be valved and where practical shall be taken off the top of the main or sub-main.
6. Structural steel shall not be cut burned or welded to aid in piping installation except with written approval of OWNER.

B. Placement of Valves:

1. Valves shall be installed at all service connections to equipment, branch lines from main lines, at low points for draining each system and as shown on the drawings.

2. Chain wheel operators shall be provided for all valves located 7'-0" or more above floor surfaces.

C. Piping Hangers and Supports:

1. All piping shall be adequately supported by means of hangers and supports. Overhead lines shall be carried directly on supports or suspended by clevis hangers from supports. All support steel, hangers, etc., shall be furnished and installed. Piping at all equipment, control valves, etc., shall be supported so that equipment, valves, etc., can be removed without further supporting the piping. Additional support for valves installed in fiberglass and PVC pipe lines shall be provided as required. Piping shall not introduce any strains or distortion to the connected equipment.
2. Spacing of supports for horizontal piping shall be no greater than shown on the following schedule or as detailed on the drawings:

<u>Steel & SS Pipe</u>	<u>Support Spacing</u>	<u>Copper Pipe</u>	<u>Support Bracing</u>
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"		
<u>Fiberglass Pipe</u>	<u>Support Spacing</u>	<u>PVC & Poly- Propylene Pipe</u>	<u>Support Bracing</u>
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" and larger	13'-0"		

3. Cast iron soil pipe shall be supported close to hubs. A minimum of one support shall be used for each pipe length.
4. Cast iron and ductile iron pipe shall be supported at each joint or at 12'-0" maximum centers, whichever is closer.
5. Hanger rods used in conjunction with clevis hangers shall be sized as indicated in the following schedule. Rods shall be cold rolled steel. Rods installed in below grade galleries, in wet wells, or within retention structure shall be stainless steel.

<u>Pipe Size</u>	<u>Hanger Rod Dia.</u>
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"

6. All stainless steel piping shall be supported with stainless steel brackets and hardware.
7. Trapeze hangers with U-Bolt type fastening may be used in lieu of clevis hangers in congested areas.
8. "Unistrut" used to support piping shall be Series P1000, galvanized, as manufactured by the Unistrut Products Co., Super Strut A-1200, Power Strut PS-200, or equal.
9. Risers shall be supported at intermediate points as required for rigidity.
10. Vertical piping shall be supported 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.
11. Hanger rods shall be connected to beam clamps, concrete inserts, or expansion shields. These devices shall be Underwriter's Laboratories approved. C-clamps will not be allowed.
12. Inserts shall be used for suspending hangers from concrete. Cadmium coated or galvanized inserts shall be used where galvanized hangers are required. Other means of setting anchors must be approved by the OWNER.
13. Perforated band iron or wire hangers shall not be used.
14. Clevis type pipe hangers shall be adjustable wrought steel. Grinnel Figure No. 260, Fee and Mason Fig. 239, Carpenter and Patterson Fig. 100, or equal, complete with bolts, rods and nuts.
15. Beam clamps shall be malleable iron with bolt, nut and pocket threaded for rod connection. Grinnel Fig. 229, or Elcen Fig. 95.

D. Unions and Flanges:

1. Unions shall be provided at all valves up to 4" size, and at final connections to equipment, or apparatus. Sufficient joints shall be provided in piping systems to provide means of readily dismantling each system. Joints shall also be provided where shown on the drawings.
2. Unions shall be of the type, material and pressure rating as herein specified for the services involved. Unions for 4 in. pipe size and larger shall be made with gasketed companion flanges or grooved pipe couplings, as specified.
3. Unions for copper pipe shall be cast or wrought copper solder type pressure fittings of suitable size and end connections.

4. Unions and companion flanges shall be installed in the pipe lines at such locations as needed to permit the removal of fixtures, apparatus or equipment without dismantling. Unions and companion flanges shall not be installed in walls, ceilings, partitions or other inaccessible locations.
5. Wherever flanges with raised faces are joined to companion flanges with a flat face, the raised face shall be machined down to a smooth matching surface and a full face gasket shall be used.

E. Reducer Fittings:

1. For proper drainage and air elimination eccentric type fittings shall be used when decrease in pipe size is necessary. Bushings shall not be permitted.
2. For water and other liquid lines top of pipe shall be installed on a continuous straight line.
3. For hot water heating, gas and air lines bottom of the pipe shall be installed on a continuous straight line.

F. Pipe Sleeves, Cover Plates & Flashings:

1. Pipe shall be provided with sleeves, flashings and plates shall be furnished, located and set for sections of the work where piping passes through floors, walls, ceilings or roof. Where sleeves pass through concrete construction, sleeves shall be located and set before concrete is poured.
2. Sleeves through concrete or masonry walls or floors shall be schedule 40 black steel pipe or molded non-metallic high density polyethylene Model CS Century-Line sleeves as manufactured by CSI-Thunderline/Link-Seal or equal. Sleeves passing through walls or floors with water, earth or weather on one side shall be provided with 1/4" thick leakplates continuously welded to the sleeves at mid slab. Floor pipe sleeves shall extend 2" above floor surface. Space between pipe and exterior sleeves shall be sealed so as to provide air tightness for above ground installations and water tightness for below grade installations. Sealing medium shall consist of synthetic rubber links, corrosion resistant pressure plates and 316 Stainless Steel bolts as manufactured by PSI-Thunderline/Link-Seal. Caulking or other type mastic sealants or lead oakum joints are not acceptable.
3. Sleeves shall be of sufficient diameter to allow for pipe insulation and its jacketing, where insulation is required.
4. Piping extending into finished areas of the building shall have chrome plated floor, wall or ceiling plates, large enough to cover the pipe sleeves.

G. Pipe Welding:

1. All pipe welding may be by either oxy-acetylene or arc method, and shall be done by approved welders, qualified in accordance with accepted "Welder Qualifications and Procedures". Welding procedures and joint quality shall strictly conform to above procedures. OWNER reserves the right to require qualifying demonstrations at the mechanical CONTRACTOR's expense, of any welders assigned to the job.

2. Tee connections in welded piping shall be made with a factory fabricated butt welding tee or with Weld-o-let of butt, socket or threaded type. When Weld-o-lets are used, 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.
 3. Long radius welding ells, shall, whenever possible, be used in changing pipe directions of welded pipe lines. Mitered joints shall not be used unless approved by OWNER.
- H. Insulated piping (FEW water piping) shall be covered with a vapor barrier jacket and regardless of jacket, shall be supported on saddles, such as Grinnel Fig. 167, Elcen Fig. 219 B-Line systems Fig. B-315, or equal.

3.05 Pipe Saddles For Insulated Piping (General)

- A. For installations where the supported weight of the pipe is sufficient to distort the pipe insulation with the shield in place, hard wood blocking shall be installed against the pipe. Wood blocking shall be the same thickness as the insulation and shall be paraffin coated. Wood blocking shall be B-Line Systems Fig. B3169, Elcen Fig. 216 or equal. Vapor barrier shall be installed over the wood blocking to maintain the integrity of the system.

3.06 Miscellaneous Iron Work

- A. Structural supports, platforms, braces or tie rods required to support or hang piping and mechanical equipment without vibration shall be furnished and installed as required or directed by OWNER.

3.07 Shop Priming Procedures

- A. Unless specified otherwise, ferrous metal items, except items to be encased in concrete and areas adjacent to field welds shall be thoroughly cleaned and prime painted as described in Section 09 9000.

3.08 Protection/Cleaning of Piping And Equipment Systems

- A. It shall be the responsibility of CONTRACTOR to install and maintain pipe and equipment which is reasonably clean and free from rust, dirt, scale, etc. Where necessary, CONTRACTOR shall provide temporary airtight covers at all pipe and equipment openings.

End of Section

Section 40 0510 Process Pipe

Part 1 General

1.01 Summary of Work

- A. 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.
- B. The requirements of Section 11 0500, Common Work Results for Equipment, and Section 40 0505, Exposed Piping Installation, form a part of this Section and govern work covered in this Section.

1.02 Related Work

- A. Section 01 3300: Submittal Procedures
- B. Section 09 9000: Painting and Coating
- C. Section 11 0500: Common Work Results for Equipment
- D. Section 33 0130: Water Utility Leak Testing and Disinfection
- E. Section 40 0505: Exposed Piping Installation
- F. Section 40 0552: Process Valves and Actuators
- G. Section 46 5111.13: Fixed Header Mechanical Aeration System

1.03 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 Section 01 3300, Submittal Procedures.
- B. Pressure Test Reports.

1.04 Delivery, Storage, And Protection

- A. Properly store, protect, and handle all pipe per manufacturer recommendations.

Part 2 Products

2.01 Piping Materials

- A. Various types of piping materials are used to meet the specific requirements of the different piping systems as indicated in the "Piping Systems Schedule." This schedule shall be followed except that where a particular piping material is chosen for a piping system that material alone shall be used throughout that entire system of pipe and fittings, except as noted otherwise on the drawings.
- B. Flanges or grooved couplings shall be installed at connections to all equipment and valves 3 inches and over.
- C. Unions or grooved couplings shall be installed at connections to all equipment and valves 2 inches and below.

2.02 Steel Pipe for Sewage

- A. Pipe 4-Inch Diameter and Larger:

1. Seamless steel ASTM A106 Grades A, ASME B31.1 with Standard (STD) thickness.
- B. Pipe Joint Interior:
1. Welded, ANSI flanged or grooved coupling in accordance with AWWA C606(Victaulic Style 07) and shall be
 2. 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 (coat exterior of pipe in accordance with Painting specifications):
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 miles.
- 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.

2.03 Steel Piping for Aeration

- A. Steel, Pipe 4 Inch Diameter and Larger:
 - 1. Pipe shall be seamless steel seamless ASTM A106 Grades A,
 - 2. Sizes in Accordance with ANSI B36.10.
 - 3. Standard Thickness (STD).
- B. Pipe Joint:
 - 1. Either welded, ANSI Cl. 150 flanged, or sleeve coupling as shown on the Drawings.
 - 2. When using sleeve couplings provide restraining rods as described in AWWA M-11.
 - 3. Grooved pipe coupling joints can be used where applicable.
 - 4. Rigid joints capable of transmitting both tensile and compressive load.
- C. Fittings:
 - 1. Seamless steel welded ASME/ANSI B16.9.
- D. Grooved Pipe Couplings
 - 1. Rigid connections: Victaulic Style 07 for pipe diameter 1-inch to 24-inch; Vic-ring Type D for larger pipe sizes
 - 2. Flexible connections: Victaulic Style 77 or equal.
 - 3. Grade "T" gaskets
 - 4. Groove pipe to provide rigid grooves in accordance with ANSI/AWWA C-606.
 - 5. Couplings shall engage the grooved pipe around the entire circumference, and bolt together with two or more track head bolts.
 - 6. Bolts and nuts:
 - a. General duty: cadmium or zinc plated
 - b. Wet well or corrosive duty: 316SS.
- E. Flanged Joints :
 - 1. Bolts, Studs, and Nuts: ASTM A307, Grade B.
 - 2. Bolt Number and Size: Same as flange standard.
- F. Gasket: 1/8-inch-thick rubber full face gaskets rated for high temperature (300F) air service, material shall be FKM or equivalent.
- G. Coat exterior of pipe in accordance with Painting specifications. Interior of pipe to remain uncoated.

2.04 Above Grade Ductile Iron Pipe (D.I.)

- A. Ductile iron pipe and fittings shall be standard cement lined and shall meet the requirements of the current ANSI A21.15, (AWWA C115), "Ductile-Iron Pipe, Centrifugal Cast in Metal Molds or Sandlined Molds, for Water or other Liquids," and ANSI A21.10

(AWWA C110) "Ductile Iron and Gray Iron Fittings 3" through 48" for water and other liquids. Cement lining shall conform to ANSI 21.4 (AWWA C104) requirements. Compact Fittings are not acceptable, except as otherwise specified herein.

- B. The minimum pipe thickness shall be Class 53.
- C. Flanged joints for above-grade piping shall be in conformity with the current ANSI B16.1, "Cast Iron Pipe Flanges and Flanged Fittings," Class 125. Non-Threaded mechanical flange fittings are not allowed.
- D. Bolts for all pipe materials shall be cadmium plated or hot-dipped galvanized as specified in Section 15030 unless otherwise specified. All bolts shall be coated with anti-seize compound prior to assembly.
- E. Gaskets for D.I. pipe shall be full face type made of minimum 1/8-inch-thick nitrile with a durometer hardness of 55 to 65 and shall conform to ANSI/AWWA A21.11/C 111 requirements unless otherwise specified. Gaskets for blind flanges shall cover the full face of the blind flange. Gaskets shall be as manufactured by Manville, Garlock or equal.
- F. Grooved Pipe Couplings:
 - 1. Grooved couplings for ductile iron pipe shall be Victaulic Style 31, or equal, with Grade "S" gaskets and grooves cut for rigid joints.
 - 2. Grooved fittings for ductile iron pipe shall be Victaulic with rigid grooves conforming 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. All bolts and nuts shall be cadmium or zinc plated except inside the wet well or corrosive areas where they shall be 316 SS.
- G. Joints for above grade piping shall be flanged or grooved pipe couplings. In general pipe connections to valves or equipment shall be flanged unless otherwise indicated on the Drawings.
- H. Flanged Coupling Adapters:
 - 1. Flanged coupling adapters shall be of the restrained type and shall be of ASTM A536 ductile iron construction with fusion bonded epoxy coating for the gasket ring. The restraining system shall consist of individually actuated gripping wedges with torque limiting actuating screws. Flange coupling adapters shall be Series 2100 Megaflange manufactured by EBAA Iron, Inc

2.05 Below Grade Ductile Iron Pipe (D.I.)

- A. Ductile iron pipe below grade shall be Class 54 and shall conform to ANSI/AWWA C151/A21.51-02 with standard cement lining. Cement lining shall conform to ANSI 21.4 (AWWA C104) requirements.
- B. Pipe joints for below grade shall be restrained push on type or mechanical joints with retainer type glands. Retainer glands shall be Series 1100 Megalug as manufactured by EbAA Iron Sales, Inc. Bolts shall be protected from corrosion by coating with Bitumastic No. 50 or cement mortar to a minimum thickness of one inch.
- C. Polyethylene wrap shall be installed on all pipes except concrete encased pipes. The polyethylene wrap shall be cross-laminated high density and manufactured of virgin polyethylene material conforming to the requirements of ASTM A-674-00.

Raw materials used for the film, its strength, thickness, tube size, or sheet width must conform to ANSI/AWWA C105/A21.5.99.

- D. All bends, tees, wyes and other special fittings shall be cast iron Class 250 conforming to ANSI/AWWA C110/A21.10-98 or ductile iron Class 350 conforming to AWWA C153/A21.53-00 with standard cement lining.

2.06 Bolted Flexible Couplings

- A. Bolted flexible couplings shall be Style 38, Dresser Couplings with plain grade 42 gaskets, or equal. Bolted flexible couplings on pressurized lines installed above grade shall be provided with restraining rods designed to resist the test pressure of the piping system.

2.07 Flexible Pipe Connectors

- A. Provide flexible connectors on inlet and outlet piping to the air blowers and as shown on the Drawings. Existing flexible coupling from the two existing blowers made by re-used.
- B. Connectors shall have one-arch synthetic rubber construction with integral 150 lb. flanged ends. Units shall be rated for temperatures up to 230° F at 65 psi.
- C. Connectors shall be Mercer spool type 100 HT, Red Valve, Proco, or equal.

Part 3 Execution

3.01 Installation

- A. Pipe and fittings shall be installed according to Section 40 0505, Exposed Piping Installation, and per manufacturer recommendations.
- B. Flanges shall be used at connections to all equipment. Where screwed ends are present, a union shall be installed.
- C. Ductile Iron Pipe:
 - 1. Flanges shall not be assembled in the field.
 - 2. The flanges shall be power assembled and screwed tight on the pipe until pipe ends project beyond the face line of the flange. The face of the flange and the end of the pipe shall be machine finished to the same plane and normal to the pipe centerline. The flange hub shall completely cover the threaded portion of the pipe so that the machined surface of the pipe is protected against corrosion. After assembly to the pipe, bolt holes shall be drilled. The holes shall accurately straddle pipe and fittings centerline. Drilled holes for flanges shall be spot faced on the back of the flanges. Flange faces shall be machined to a smoothness of not less than 125 rms.
- D. Coated Steel Pipe Joints:
 - 1. Joints shall be primed and taped per the coating manufacturer's recommendation. Coating shall be as manufactured by Standard Pipe Protection or equal.
 - 2. Piping shall be handled with rope or burlap slings. No metallic pipe handling equipment shall be allowed.
 - 3. Trenches shall be backfilled with sand. No stones shall be allowed in the backfill material.

4. Pipe, during manufacturing, upon delivery and after placement, shall be subject to inspection and testing.

3.02 Prevention of Electrolysis

- A. Insulating couplings shall be provided at all joints between piping systems constructed of dissimilar metals.

3.03 Pressure Tests

- A. Piping shall be hydrostatically pressure tested according to Section 40 0505, Exposed Piping Installation.

3.04 Disinfection of Domestic Water Piping System

- A. Disinfect potable water distribution system in accordance with Section 33 0130, Water Utility Leak Testing and Disinfection.

3.05 Painting

- A. Ductile, Cast Iron, Carbon Steel, Copper and Plastic pipe shall be painted according to Section 09 9000, Painting and Coating, of these specifications.
- B. Stainless steel pipe and tubing shall not be painted.
- C. The following schedule shall be used for painting items specified herein:

Item	Painting System No.
Exterior ferrous piping	1
Interior ferrous piping (not specified elsewhere)	2
Submerged and non-submerged ferrous piping, brackets, and structures in corrosive areas	6

3.06 Piping Schedule (P Sheets)

Piping System	Materials
Air	STL. & SS
Air (S)	SS
Wastewater	D.I.
Water Main (E) & potable water	Copper
Water Main (B)	D.I.

Notes:

1. B - Below Grade; E - Exposed; S-Submerged
2. Piping shall be tested in accordance with local Plumbing Codes and certified.

End of Section

Section 40 0552

Process Valves and Actuators

Part 1 General

1.01 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. Valves shall comply with the American Iron and Steel (AIS) requirements of the Consolidated Appropriations Act of 2014 (Public Law 113-76).

1.02 Related Work

- A. Section 01 3300: Submittal Procedures
- B. Section 01 7700: Closeout Procedures
- C. Section 09 9000: Painting and Coating
- D. Section 11 0500: Common Work Results for Mechanical
- E. Section 40 0505: Exposed Piping Installation - General
- F. Section 40 0510: Process Pipe

1.03 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.

1.04 Submittals

- A. Shop drawings and Operation and Maintenance Manuals as specified in Section 01 7700 are required for each item in this Section of the specifications, including, but not limited to valves, actuators, manual operators, pneumatic cylinders, flushing monitors, etc.

1.05 Warranty

- A. The warranty period for all items covered by this Section of the Specifications, except electric actuators, shall be two years from the date of equipment start up as specified in the General Conditions. Electric actuators shall be warranted against defects in workmanship and material as specified hereinafter.

Part 2 Products

2.01 Plug Valves

- A. Type P-1F (Full Port) for Sewage and Sludge Service:
 - 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. All plug valves shall have operators as noted on the schedule. 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, Val-Matic, Pratt, or Crispin.

2.02 Check Valves

- A. Type C-1(Outside Lever & Spring):
 1. Check valves 6" and larger shall be flanged, 125 psig, swing type. Valves shall have cast iron bodies and discs, stainless steel shaft and Buna-N disc seat. Valves shall be complete with outside lever and spring suitable for vertical or horizontal service and shall be Apco, Val-Matic, Crispin or Pratt.
 2. Check valves 2" to 6" in size shall be flanged, 125 psig, swing type, cast 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 Apco, Val-Matic, Crispin or Pratt.
- B. Type C-3:
 1. 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, Jenkins Model 762C, Stockham Model B-345 or equal.
- C. Type C-5:
 1. Ball check valves for plastic piping systems shall be of polyvinyl chloride construction, 150 psi rating, screwed union body with socket weld ends and Viton "O" ring seals. Valves shall be as manufactured by Nibco, Hayward, Asahi-America, or Colonial Valve.

2.03 Ball Valves

- A. Full port ball valve, bronze for water/air service, PVC for chemical service.

2.04 Butterfly Valves

- A. Type BF-2 (Air Valves):

1. Butterfly valves 4-inch in diameter and greater shall be flanged, 150 psi rated with ductile iron body, 316SS disc and shaft stainless steel, bronze or acetal bushings, and EPDM seats and seals suitable for air service. Valves shall have electric actuators unless indicated otherwise.
 2. Valves shall be DeZurik, Val-Matic, Crispin or Pratt.
- B. Type BF-3:
1. Butterfly valves 2-inch in diameter shall be flange type design, 150 psi rated with ductile iron body, 316SS disc and shaft, bronze bushings and Teflon seats and seals. Valves shall have lever operators.
 2. Valves shall be DeZurik, Val-Matic, Crispin or Pratt.

2.05 Operators

- A. Wrench Nut (WN):
1. Wrench nut operators shall be provided, as indicated in the "Valve Schedule" and shall be 2-inch square nut for operation by a T-handle wrench. Wrench nuts shall be provided with a cast iron valve box.
- B. Lever Operators (L):
1. Lever operators shall be provided, as indicated in the "Valve Schedule" or shall be provided for all air service valves which are not equipped with electric actuators and all valves 2" and smaller.
 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.
- C. Gear Operators (G):
1. Gear operators shall be provided for all manually operated valves to ensure that the maximum force required for opening via wrench nut or handwheel is 30 lbs. Gear mechanism shall be the totally enclosed type, totally sealed for submersible installation. Gear operator shall be selected to operate the valve at the indicated test pressure on the Piping Schedule. Gear operators for buried or submerged valves shall be sealed and specifically designed for buried/submersed service, including those operators in the clearwell and settling basins. Operating shaft to be supported axially and radially at the input end by permanently lubricated thrust and sleeve bearings, the actuator shall be mounted to the valve with stainless bolting.
- D. 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.
- E. Chainwheel Operators (CW):
1. Valves shall be provided with chainwheel operators wherever indicated and where valve operator centerlines are installed higher than 7'-0" above the floor.

F. Electric Actuators (EM, EMR, EMS, EMX):

1. General:

- a. Valves or gates where called for on the Drawings or indicated in the valve schedule, shall be furnished with electric motor operators.
- b. 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 minutes for quarter turn valves, or the operating speed shall be not less than 12" (min.) for gates.
- c. 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.
- d. Two sets of limit switch 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.
- e. Unless specified otherwise herein, power to each operator shall be 240-volt, 3 phase, 60 Hz., and all electrical enclosures shall be NEMA Type 4 watertight (operator type EM), suitable for outdoor installation. Each operator housing shall be of ductile iron or die cast aluminum construction. Actuators type EMR shall be 120-volt, single phase, 60 Hz with NEMA Type 4 electrical enclosure.
- f. Electric actuators shall be manufactured by Rotorque.
- g. Modulating Service:
 - (1) The two 4-inch air valves feeding the grit tanks which are being replaced shall be provided with modulating service. 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.
- h. 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 (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 AQ, as manufactured by Rotork. 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.

i. Multiple Turn Movement:

- (1) Valves which require multiple turn movement shall be provided with Model IQ/Bevel Gear valve actuators, as manufactured by Rotork.
- (2) In all other respects, all requirements of paragraph 2.21 E.1.d shall apply to these actuators.

j. 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.

G. 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:

- (1) Extension Stems: Type 304 S.S.
- (2) Couplings: Bronze or Stainless Steel
- (3) Chains: Galvanized Steel
- (4) Valve Boxes: C.I. with 8" clear opening and removable cover
- (5) Operating Nuts: 2" square cast iron
- (6) Floor Stands: Fabricated steel or cast iron

2. Floorstands/Neck Extensions:

- a. Valves shall be provided with floorstands whenever indicated in the valve schedule or on the Drawings.
- b. Manually operated floor stands will be right angle crank or handwheel type as indicated in the valve schedule or called for on the Drawings.

- c. 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. Pinion shafts shall be supported on tapered bearings. Components shall be totally enclosed in a cast iron case and cover.
 - d. 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.
 - e. 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.
 - f. Neck extensions shall be supplied by the valve manufacturer, they shall be designed to seal the neck of the valve and support the actuator properly when actuated. The outer support piping shall not require external supports under 15-foot lengths. The inner pipe shall be sized not to twist and shall include any supports required within the outer pipe to allow full operation of the disc and allow the actuator to hold any mid-travel position without fluttering. The neck extension shall be stainless steel.
3. Limit Switches (LS):
- a. 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, cam-operated, adjustable throughout travel range and rated at 10A for 120/240 V service.
 - b. Two limit switches which provide overlapping open and close dry contacts for remote monitoring shall be provided for each valve so designated.
4. Position Indicators (PI):
- a. Visual valve position indicators shall be provided on all modulating valves and shall be model BM3-5 as manufactured by Westlock Controls Corp.

Part 3 Execution

3.01 Installation

- A. Piping and valve installation shall be as specified in other applicable sections of these specifications.

3.02 Tests

- A. All motor, pneumatic, hydraulic and solenoid operated valves shall be field tested. Field testing shall include local and remote operation and all alarm functions (if applicable).

- B. Automatically operating valves shall be adjusted to the set points specified or those identified by ENGINEER. Testing shall then be conducted to verify operation including any alarm functions.

3.03 Manufacturer's Field Service

- A. A factory representative employed by the manufacturer shall visit the site prior to equipment start-up to verify the proper installation of the equipment and to instruct OWNER's operating personnel in the maintenance and operation of these units. The scheduling of this service shall be coordinated with OWNER and the cost of this service shall be included in CONTRACTOR's bid price.
- B. Operation and maintenance training shall be provided for each type of actuator, unless otherwise specified.

3.04 Painting

- A. The following schedule shall be used for painting items specified herein:

Painting Item	System No.
Exterior, valves & operators	1
Interior, valves & operators (not specified elsewhere)	2
Submerged and non-submerged valves & operators in clearwell or settling basin	7
Buried Valves	6

- B. For detailed painting requirements and system descriptions refer to Section 09 9000 of the Specifications.

3.05 Storage of Material

- A. Material shall be stored prior to installation in accordance with Sections 01 6000, Product Requirements, 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.

End of Section

Section 40 0560

Fabricated Stainless Steel Gate

1.01 Part 1 General

1.02 Description

- A. CONTRACTOR shall furnish all tools, supplies, materials, equipment and labor necessary for the installation of fabricated stainless steel slide gates, complete and operable, in accordance with the Contract Drawings.
- B. CONTRACTOR shall assign full responsibility to a single manufacturer for the furnishing and functional operation of the slide gates, actuators, and appropriate accessories. The designated single manufacturer shall coordinate the assembly, testing, and erection of the units as specified herein.
- C. Electric motor actuators are specified in Section 26 0913.13, and they shall be provided with the gates under the provision of that section.

1.03 Quality Assurance

- A. The slide gates and all appurtenances shall be designed, manufactured, and tested in accordance with federal, state, and local requirements and applicable sections of the latest editions of the following codes and standards:
 - 1. ASTM - American Society for Testing and Materials
 - 2. ANSI - American National Standards Institute
 - 3. JIC - Joint Industrial Council
 - 4. NFPA - National Fluid Power Association
- B. Manufacturer's shop welds, welding procedures and welders shall be qualified and certified in accordance with the requirement of the latest edition of ASME, Section IX.
- C. Fabricated stainless steel gates shall be shop tested for leakage and proper operation before shipping in accordance with AWWA C561 Section 5.2. Shop testing shall confirm compliance with the leakage rate as specified in this specification.
- D. A gates and operators shall meet the requirements of AWWA C561, latest edition, except as modified in this specification.

1.04 Submittals

- A. Shop Drawings: Submit complete shop drawings of all gates, frames, slides, mounting hardware and appurtenances, as well as design load calculations for deflection at the head indicated in the schedule, and calculations for the lifting force required to lift the gate at seating and unseating heads, as listed in the schedule.
- B. Tools: Special tools necessary for maintenance and repair of the slide gates shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

2.	Stems	Rolled stainless steel, ASTM A276, Type 316
3.	Fasteners	Stainless steel, ASTM 276 or 240, Type 316, Gr 2
4.	Anchors	Stainless steel, ASTM 276 or 240, Type 316, Gr 2
5.	Resilient Seals	Neoprene D2000, Grade AA625
6.	Guides/Pressure Pads	Ultra-high molecular weight polymer (UHMWP)

- B. Frame: Gate frame shall be flat/flange back or channel-mounted as shown in the gate schedule. Frame shall be an integral unit of structural shapes, rigidly welded to form the waterway opening. Frame members shall form guides for the slide, and holes shall be provided for mounting on anchor bolts, coordinated with location of existing flange embedded in concrete behind existing gate. Frame mounting shall not require "box-outs". Guide slot of the frame shall contain UHMWP adjustable pressure pads, with a maximum spacing of 12 inches, to provide adjustable seal compression. The part of the frame guide in contact with the seal shall be finished smoother than 125 micro-inch rms. Frame bottom member shall be a stainless steel shape to provide a sealing surface flush with the invert of the gate opening, finished to accept flush bottom seals mounted on the slide.
- C. Yoke: Self-contained gates shall include a yoke consisting of two structural shapes welded to the top of the frame sides, or guides. The yoke shall be fabricated such that the slide may be removed without yoke removal. Yoke deflection shall not be more than 1/360th of the gate width under operating (opening) loads at scheduled seating head. If shown, the yoke elevation shall be at the elevation shown on the drawings, to allow access to the operating cylinder and instruments from platforms provided by other section of the work.
- D. Slide: Gate slide shall be designed such that deflection under full head shall be limited to 1/1000 of the span, or 1/16 inch, whichever is less. The stem connector clips or stem block pocket shall be welded to the slide, and the stem bolted thereto. Gate seals, including the bottom flush seal, shall be fastened to the slide with stainless steel and UHMWP fasteners and grommets.
- E. Seals: Fabricated stainless steel gates shall be provided with a self-adjusting seal system utilizing UHMWPE seals and/or resilient compression cords. All seal components shall be mechanically fastened to the frame or slide. Seal components shall be capable of being removed and replaced with standard tools without removal of the gate frame from the wall.
1. Self-adjusting seals shall be designed with to ensure contact between the UHMWPE guide and the gate in all positions.
 - a. Sealing system shall maintain efficient sealing in any position of the slide and allow the water to flow only in the opened part of the gate.
 2. Guides shall be made of virgin UHMWPE (ultra-high molecular weight polyethylene) to restrict leakage, prevent metal-to-metal contact between the frame and the slide, and provide long-term maintenance free operation.
 3. Top seal shall be the self-adjusting type, utilizing a cup shaped UHMWPE seal with twin contact surfaces and compression cord. The cup shaped seal with twin contact surfaces shall be designed with the outer seal acting as a wiper to remove debris from the slide when raising the gate thereby protecting the primary seal.
 4. Flap gate resilient seals shall be mechanically secured to the gate frame, and shall be replaceable in the field. All fastening devices shall be stainless steel of the same alloy as the gate.

- F. Stems: Gate stem diameter shall be adequate to withstand 1.25 times the maximum force created by the hydraulic or motor actuator, or twice the force generated by manual operators. Stems shall have ACME cut threads with a maximum roughness of 16 micro-inches. Stem shall be supported by cast iron bronze bushed stem guides, spaced to provide an l/r ratio of 200 or less.
- G. Gate Operator: Refer to Section 26 0913.13, Actuators and Operators.
- H. Manufacturer: Rodney Hunt

Part 3 Execution

3.01 Installation

- A. New gates shall be surface mounted on concrete walls. Space between the gate frame and wall shall be sealed with non-shrink grout, as recommended by the manufacturer. Leakage through this space shall be considered a gate leak under Article 3.02 of this specification.
- B. Fabricated gates shall be installed in strict accordance with the manufacturer's printed recommendations and the requirements herein. Operators shall be located to avoid interference with handrails and structural members.
- C. Anchor Bolts and Fasteners: Anchor bolts, nuts, washers, and fasteners shall be furnished with the equipment herein specified and set in conformance with templates or drawings also supplied by the manufacturer. Anchor bolts, studs, fasteners, washers, and nuts shall be Type 316 stainless steel. CONTRACTOR shall install all anchor bolts, studs, washers, nuts and fasteners required to complete the work of this Contract.
- D. Damage to surface coatings shall be repaired to the satisfaction of ENGINEER prior to installation.
- E. Alignment: Equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, or other defects. Equipment shall be secure in position and neat in appearance.

3.02 Equipment Testing

- A. CONTRACTOR shall be responsible for the coordination of the tests of each fabricated gate structure in the presence of the manufacturer's factory service representative. Excessive leaks shall be corrected, and the equipment retested until found satisfactory.
 - 1. Leakage allowance for slide gates shall not exceed 0.1 gpm/ft of seating perimeter under 20 ft of seating head, and 0.2 gpm/ft under 20 ft of unseating head, to meet ANSI/AWWA C-561.

3.03 Cleanup

- A. After completion of the installation and testing, CONTRACTOR shall remove all debris from the site, clean all the equipment and controls, and hand over his work in perfect operating condition.

End of Section

Section 40 7100 Flow Measurement

Part 1 General

1.01 Scope of Work

- A. Field-mount Flow measuring and sensing Instruments, and associated devices and appurtenances.

1.01 Related Sections

- A. Section 26 0900: Instrumentation and Control for Electrical Systems - General
- B. Section 26 0705: Electrical Testing and Equipment
- C. Section 26 0800: Commissioning of Electrical Systems
- D. Section 26 0710: Demonstration and Training for Electrical Systems

1.02 Regulatory Requirements and References

- A. Conform to requirements of NFPA 70 National Electrical Code.
- B. Furnish Products listed and classified by Underwriters Laboratories, Inc. (UL), Factory Mutual (FM), and/or Canadian Standards Association (CSA), as specifically indicated, as acceptable to the authority having jurisdiction, and as suitable for purpose Specified, and as indicated on the Drawings.
- C. Equipment and workmanship shall be in conformance with all applicable standards and requirements of any and all Federal, State, and/or local codes, ordinances, or regulations, including OSHA/MIOSHA.
- D. Products shall meet the latest approved standards of ISA, IEEE, ANSI, NEMA, and Underwriters' Laboratories, including, but not limited to:
 - 1. ANSI/ISA applicable standards for measurement and instrumentation.
 - 2. NEMA, including ICS 1, General Standards for Industrial Control Systems; NEMA ICS 2, Standards for Industrial Control Devices, Controllers and Assemblies; and NEMA ICS 6, Enclosures for Industrial Controls and Systems.

1.03 Submittals

- A. Shop drawings shall be submitted in accordance with Section 01 3300, Submittal Procedures.
- B. Shop Drawings shall indicate electrical characteristics and connection requirements, including layout of complete assemblies, interconnecting cabling, dimensions, weights, and external power requirements for each Product supplied. Provide Product Data showing manufacturer's specifications, electrical characteristics, and connection requirements for each Product supplied.
- C. Include Application and Installation Instructions indicating all conditions and limitations of use stipulated by the manufacturer, and/or Product Testing Agency, and any instructions for storage, handling, protection, examination, preparation, installation, and starting for each Product supplied.

1.04 Project Record Documents

- A. Submit under provisions of Section 01 6000, Product Requirements and Section 01 7700, Closeout Procedures.
- B. Record actual locations of primary devices, and other devices connected to instruments. Include interconnection wiring and cabling information, and all terminal arrangements.

1.05 Operation and Maintenance Data

- A. Operation and maintenance manuals shall be submitted in accordance with Section 01 6000, Product Requirements and Section 01 7700, Closeout Procedures.
- B. Installation and Start-Up Requirements shall be clearly identified, described and/or detailed. Include bound copies of programming and operating instructions.
- C. Maintenance data shall include component parts diagrams and lists, calibration, adjustment, and preventative maintenance procedures, troubleshooting procedures, and repair or replacement procedures.

1.06 Qualifications

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years documented experience.
- B. Supplier: Authorized distributor, or representative of specified manufacturer with minimum three years documented experience.

1.07 Delivery, Storage, And Handling

- A. Deliver, store, protect, and handle Products to site under provisions of Section 01 6000, Product Requirements.
- B. Accept products on site in factory containers. Inspect for damage. Store products in clean, dry area; maintain temperature to NEMA ICS 1.

1.08 Environmental Requirements

- A. Instruments shall be provided in enclosures, or housings, suitable for the environment of the intended installed location, as shown on the Contract Drawings, and as described hereinbelow.
- B. Manufacturer shall provide integral heater(s) and/or cooler(s) where required for proper operation under normally expected conditions.
 - 1. Normal ambient temperatures at the facility site range from minus 30 to plus 45 degrees Celsius (minus 25 to plus 115 degrees Fahrenheit).
 - 2. Instruments in outdoor locations shall be suitable for operation under these conditions, while in direct sunlight, or under windy conditions with associated "chill" factors.
- C. Maintain instruments free of dirt and dust during and after installation.

Part 2 Products

2.01 Magnetic Flowmeter Systems (FE/FTI)

- A. Magnetic Flowmeter shall be manufactured by ABB, Siemens, or approved equal.
- B. Each magnetic flowmeter system shall consist of a magnetic flowmeter (FE) and a flow transmitter indicator (FTI). The size of the meters and flow ranges shall be as shown on the Contract Drawings.
- C. Each magnetic flowmeter shall be of the DC type and shall be equipped with: tungsten carbide, stainless steel or platinum electrodes; copper magnetic coils; a lined stainless steel flow tube, with welded steel housing, and with ANSI Class 150 flanges on both ends; two metallic liner protectors, which shall serve as grounding rings; and, two ground straps. A wafer-style body to mount between two ANSI Class 150 flanges and the two grounding rings shall be allowed for meters smaller than 6-inches in size.
- D. The flow tube liner shall be neoprene or polyurethane for wastewater or sludge streams, and PTFE for chemical streams. Electrodes and liner protectors shall be of material suitable for use with the liquid stream being measured.
- E. The flow transmitter shall accept the millivolt signal from the magnetic flowmeter and convert the signal into a 4-20 ma linear flow signal as well as a scaled pulse output. Accuracy shall be +/- 0.5 percent of rate of flow from 1 foot per second (FPS) to 32 FPS. The signal converter shall: be microprocessor based; have adjustable damping up to 90 sec/full scale response to 100 percent step change; provide full isolation of I/O; maintain continuous zero stability.
- F. The flow transmitter shall operate at 120 VAC and be housed in a remote mounted waterproof and splash proof enclosure for protection of electronic parts. A flow indicator calibrated in gallons per minute (GPM), or other engineering units, as shown on the Drawings, shall also be provided.
- G. Magnetic flowmeters installed in below-grade locations shall be suitable for occasional submergence: 30 ft. for 72 hours (minimum). All necessary appurtenances (sealing fittings) for the field installation to meet this submergence requirement shall be included with the meter.

2.02 Calibration

- A. Each Thermal-Dispersion flow sensor and flow transmitter shall be provided with a certified calibration traceable to NIST.
- B. A copy of the manufacturer's configuration software and any necessary cables shall be provided to Owner, for use in calibrating each of the flow transmitter instruments. If and only if software is not available, then flow instruments with calibration only from the Flow Transmitter shall be acceptable.

2.03 Air Flowmeter Transmitter Indicators (EF/FTI)

- A. Air flow transmitter indicators shall be as manufactured by ABB, or Rosemount 3051 Series, Pressure Transmitter, or equal.
- B. The flowmeter orifice plate assemblies shall be as manufactured by ABB FPD150 Series, Rosemount, or equal.

2.04 Air Flowmeter Indicators (FE/FI)

- A. Each air flowmeter indicator system shall consist of an orifice plate assembly (FE) sensing port shutoff valves and a flow indicator (FI). The size of the flow indicators and flow ranges shall be as shown on the Drawings, and as described herein.
- B. Each orifice plate assembly shall be of the weld-on, flange insert type and shall be complete with tapped flanges of carbon steel construction, with a ¼ inch thick, sharp edge type orifice plate of type 316 stainless steel construction. The orifice shall produce a maximum differential pressure of 25 inches of water column.
- C. Each orifice plate assembly shall be provided complete with sensing tap shut-off-valves. Hard Copper tubing and fittings required to connect the remotely mounted flow indicator shall be furnished and installed by the installing Contractor.
- D. Each flow indicator shall accept the differential pressure signal from the flow tube and convert the signal into an indication of visual flow rate. Accuracy shall be +/- 5% of rate of flow.

2.05 Pressure Transmitters

- A. Pressure transmitters, and differential pressure transmitters shall be as manufactured by ABB, Rosemount, or equal.
- B. Differential pressure transmitters may be used where gage pressure transmitters are specified. Gage pressure transmitters may not be used where differential pressure transmitters are specified.
- C. Configuration software and cables shall be compatible with transmitters.
- D. The differential pressure transmitters shall be smart electronic differential pressure transmitters to convert inches water into a 4-20 mADC signal for level or differential level indicators and recorders. The transmitters shall be provided with integral three valve manifold and 1500 psig over range protection. Accuracy shall be 0.1% of span and repeatability shall be 0.1% of span. An integral indicator for reading output signal in engineering units shall be provided for each differential pressure transmitter.

2.06 Calibration

- A. Each air flow tube and flow transmitter, and each air flow orifice plate assembly and flow indicator, shall be provided with a certified calibration traceable to NIST.
- B. A copy of the manufacturer's configuration software and any necessary cables shall be provided to OWNER, for use in calibrating the flow transmitter instruments. If software is not available, then two (2) handheld configurators shall be provided to OWNER.

Part 3 Execution

3.01 Installation

- A. Install in accordance with manufacturer's instructions.
- B. Do not install products until major construction is complete and building interior is enclosed and heated.
- C. Make all instrumentation interconnections (process, electrical, etc.) as indicated and required for proper operation and intended use.

- D. See Section 26 0553, Identification for Electrical Systems, for nameplate, circuit number marker, and wire marker, etc. requirements.

3.02 Field Quality Control

- A. Field inspection and testing shall be performed under provisions of Section 26 0705, Electrical Testing and Equipment.
- B. Perform operational testing on instrumentation and control systems to verify proper operation and field wiring connections.

3.03 Manufacturer's Field Services

- A. Prepare, calibrate, and start systems under provisions of Section 26 0800, Commissioning of Electrical Systems.
- B. Calibrate and/or verify each device for the zeros, ranges, and spans indicated on the Drawings.

3.04 Demonstration

- A. Demonstrate calibration and operation of devices.
- B. Provide systems demonstration under provisions of Section 26 0710, Demonstration and Training for Electrical Systems.
- C. After acceptance of the flow instrument equipment, OWNER's operators shall be provided with one-half day (minimum) of onsite training in the use and maintenance of each type of the equipment. Training shall cover the calibration of the flow instruments, preventative maintenance of all equipment, and troubleshooting and repair/replacement procedures.

3.05 Spares

- A. In addition to the installed equipment, as Specified above, and as shown on the Drawings, provide one spare of each type transmitter-indicator, and one spare of each type of flow switch, each packaged as indicated in Section 26 510, Basic Electrical Materials and Methods.
- B. Turn over calibration devices(s), software, and all spares at the time of, and as a condition of, acceptance.

End of Section

Division 41
Material Process and Handling Equipment

Section 41 1213.37

Submersible Screw Conveyors

Part 1 General

1.01 Summary

- A. Scope of Work: Provide submersible screws on each of the two aerated grit chambers as shown in the drawings. Screws shall be complete systems including drives and motors and all support appurtenances as detailed herein.

1.02 Reference standards

- A. American National Standards Institute (ANSI)
- B. American Institute of Steel Construction (AISC)
- C. American Society of Testing and Materials (ASTM)
- D. American Gear Manufacturers Association (AGMA)
- E. Conveyor Equipment Manufacturers Association (CEMA)
- F. National Electrical Manufacturers Association (NEMA)
- G. Occupational Safety and Health Administration (OSHA)
- H. American Welding Society (AWS D.1.1-90)

1.03 Submittals

- A. General:
 - 1. Submit Product Data and Shop Drawings in sufficient detail to confirm compliance with requirements of this Section. Submit Product Data and Shop Drawings in one complete submittal package. Partial submittals are unacceptable.
- B. Shop Drawings:
 - 1. Installation drawings and specifically prepared technical data, including design capacities.
 - 2. Specially prepared wiring diagrams unless standard wiring diagrams are submitted with Product Data.
 - 3. Layout drawings to include supports, accessories, appurtenances-coordination with peripheral equipment, drives, and required clearances.
- C. Product Data:
 - 1. Catalog cuts and product specifications for each product component specified in this Section.
 - 2. Standard wiring diagrams unless wiring diagrams are specially prepared and submitted with Shop Drawings.
 - 3. Catalog cuts and product specifications for control devices.
 - 4. Proposed coating. Submittal information will be in accordance with Section 09 9900.
- D. Operation and Maintenance (O&M) Data:
 - 1. Submit in accordance with Section 01 7700, Closeout Procedures.

1.04 Services of Manufacturer

- A. Inspection, start-up, and field adjustment as noted in Part 3 of this Section.
- B. Instruction of Owner's Personnel: The authorized service representative will also furnish the indicated services for instruction of OWNER's personnel in the operation and maintenance of the equipment including step-by-step troubleshooting procedures with necessary test equipment.

1.05 Qualifications of Manufacturer

- A. Supplier and/or manufacturer will have been in the business of designing and manufacturing "Waste Treatment Conveying Systems" for a minimum of ten (10) years and have "in-house" fabrication, painting and assembly capabilities to ensure quality control. Supplier and/or manufacturer will allow periodic inspection of work in progress when requested.

1.06 Environmental Conditions

- A. Equipment located outdoors; submerged in wastewater when in operation; may be exposed to atmosphere when idle.
- B. Outside air characteristics:
 - 1. Temperature: -20 to 100 degrees Fahrenheit.
 - 2. Relative humidity: 30% to 100%.
- C. Wastewater characteristics:
 - 1. Municipal wastewater with small amounts of industrial waste.
 - 2. Some petroleum products, industrial solvents, detergents, oils, grease, fats, biological solids, and dissolved organic materials.
 - 3. Temperature: 50 to 75 degrees Fahrenheit.
 - 4. pH: 6.0 to 8.5.

1.07 System Requirements

- A. Conveying system shall be fabricated to be compatible with grit pumps.
- B. Provide conveyor screws, drive motors, right-angle gear reducers, hanger bearings, end bearings, lubrication and vent lines, pick-up pans, and miscellaneous appurtenances required for complete installation.
- C. Conveyor screws shall run in a concrete trough and be positioned to collect and convey grit to the grit pump.
- D. Conveyor shall be designed to convey grit with bulk density of 100 pounds per cubic foot motor sized to start conveyor 100% full of grit.
- E. Provide one (1) complete system for each of two (2) cells within existing aerated grit chambers.

Part 2 Products**2.01 Acceptable Manufacturers**

- A. Custom Conveyor Corporation, Rogers, Minnesota

2.02 Conveyor Screw

- A. Size and type: 20-inch diameter, right hand with 3/8-inch thick, half-pitch, sectional butt-welded flighting, with 2 inches of hardfacing on carry side and entire periphery. Nominal length of screw to be 30 feet, see drawings (field verify).
- B. Flighting: Welded to 4-inch diameter, schedule 40 pipe with bushings each end for 3-inch diameter couplings.
- C. Furnish 3" diameter end shafts and coupling shafts with standard CEMA drilling for hardened couplings bolts.
- D. Flighting, shafts, and couplings: Type 304 stainless steel.

2.03 Drive Assembly

- A. Motors:
 - 1. Motors shall be 5 Hp (minimum) and have of energy efficient design meeting or exceeding NEMA MG1-Table 12-10 and EP Act guidelines. Refer to Division 26 for motor requirements. The motors shall be 230/460-volt, 60 Hz, 3 phase, 1800 rpm, conforming to the General Equipment specifications, except as modified herein. Each motor shall be 40 degrees Celsius ambient rated, 3300 feet (1000m) altitude or lower operation, with a maximum temperature rise of 80 degrees Celsius by resistance at 1.0 service factor (95 degrees Celsius rise at 1.15 s.f.). Motors shall have Class B insulation with Design B speed/torque characteristics in accordance with NEMA MG1-12.35 and 12.38, and be C face type, with NEMA frame sizes.
 - 2. Type: Horizontal, squirrel cage induction, solid shaft.
 - 3. Enclosures: TEFC, suitable for unclassified locations.
 - 4. Ratings:
 - a. Inverter duty.
 - b. 5 HP (min), 1,750 RPM; capable of starting conveyor 100% full of product (settled wastewater grit).
 - c. Voltage: 460 volts, 3-phase, 60 Hz
- B. Gear Reducer:
 - 1. Each conveyor shall be driven by a gear reducer motor drive unit. The RPM range shall be between 1 and 10 RPM based on a variable frequency controller for the motor.
 - 2. Gears shall be AGMA Class II, helical gear SEW Eurodrive right angle units or equal with high capacity roller bearings and adapter for NEMA frame motors. Bearings shall be designed for the thrust loads from the fully loaded startup condition and shall have an AFBMA B-10 life of 80,000 hours. Reducer shall be air-cooled unit with no auxiliary cooling requirement.
 - 3. Drive end shaft shall utilize a flexible coupling between the reducer shaft and the pillow block bearing. The coupling shall be Dodge Para-Flex taper lock model PX160TL or equal. It shall be sized to accommodate the reducer output torque. Drive end shaft shall be minimum 3-inch diameter, 304 stainless steel.

4. Provide fabricated steel (A36) drive base with coupling guard and type E pillow block bearing wall mounting plate with flange gland seal and type E pillow block bearing.
- C. Chain and Sprocket:
1. Drive end shaft will connect to flighting end shaft thru a chain and sprocket drive with stainless steel oil bath chain guard. Driven sprocket will incorporate a shear pin hub assembly

2.04 Wall Seal

- A. Cast iron stuffing box with min. (5) ring Teflon impregnated packing. Note that the existing screw shaft is 3.5" diameter with a 4.5" collar. The intent is to maintain the existing opening in the concrete wall with the new shaft and provide a seal plate.
- B. Minimum 1/2-inch thick wall mounting plate with bearing mounting bracket to be anchored to existing concrete wall or the manufacturer shall supply a means to completely seal the shaft opening thru the wall to prevent the liquid contents of the grit tank from entering the basement area of the pump room.

2.05 Troughs

- A. Trough shall conform to CEMA Standards and be manufactured from T-304 stainless steel.
- B. Troughs shall be grouted into place by the contractor.
- C. Minimum trough thickness (inch): 3/16 in.
- D. Trough shall be equipped with a 1/4" thick, roll formed, abrasion resistant (AR235) steel trough liner. Liner shall be tack welded into place.
- E. A neoprene or rubber gasket shall be provided at each trough flange.
- F. Stiffeners shall be placed across the top of the trough and fastened to both sides of the trough to maintain trough shape.

2.06 Hanger Bearings

- A. Furnish Style 226 hanger bearing frames with stellite inserts and spaced as required to limit conveyor deflection to 1/4-inch. Hanger bearing frames shall be 304 Stainless steel.
- B. Suitable for submerged service.
- C. Provide 1/4-inch diameter stainless steel grease line. Install inside 3/4-inch stainless steel conduit extended from bearing to operating platform as shown on drawings.

2.07 Coating

- A. Steel which is not stainless steel shall be coated in accordance with Section 09 9900.

2.08 Controls

- A. grit screw conveyor manufacturer shall provide all of the equipment including the variable frequency drive as specified herein. The VFD Control Panels shall be NEMA 4X 316 SS for wall mounting in the aerated grit chamber control building. The panel size shall be 30"x 36" x 12".

- B. Custom Variable speed drives shall be provided to control the speed of the grit conveyors both in the "Local" position as well as in the "Remote" position from the plant SCADA System. The VFD shall be Rockwell Series A-B Model 755 as shown on the drawings. The enclosures shall include the following components:
1. Door interlocked disconnect switch
 2. Fused control transformer
 3. Hand – Off – Auto selector switch for Local or Remote control
 4. Push buttons: Pump Start (red), Pump Stop (green), and Emergency Stop (red)
 5. Indicator lights: Running (red), Fail (yellow), and Power On (white)
 6. Network Communications: Ethernet Communications module to interface with the Control System network. Note: IP configurations will need to be provided to the Grit Screw Drive manufacturer 2 weeks prior to scheduling initial start-up visit.
 7. Install unmanaged Ethernet switch for connection to the control system network.
 8. Install OEM supplied TSUBAKI model TSBSB Shock Relays for overload protection into circuitry for the VFD control panels.

2.09 Field Testing

- A. Perform testing checkout, and start-up for variable frequency drive equipment under technical direction of qualified field service engineer. Under no circumstances energize any portion of the drive system without authorization from the grit screw drive manufacturer's technical representative.
- B. Field Tests:
1. Test each drive over the total speed range that it will be required to operate through for the load being driven for a minimum of two hours. Determine for each drive, motor, and load combination the following at minimum speed, maximum speed, and at 1/3 and 2/3 points between the minimum and maximum speeds:
 - a. Input power (kW), voltage, current and RMS power factor on the line side of the drive isolation device.
 - b. Output to the driven load in kilowatts.
 - (1) Test each drive by using the actual control signal for remote and local operation.
 - (2) Test each drive's alarm functions used.
 - (3) Perform all tests in the presence of OWNER's representative.
 - (4) Submit final test report with summary for each drive.
 - (5) Testing determined not in compliance with Contract documents shall be repeated by CONTRACTOR at no additional cost to OWNER.

Part 3 Execution

3.01 Spare Parts

- A. Provide the following spare parts
 - 1. One (1) set hanger bearing inserts
 - 2. One (1) set coupling shafts and coupling bolts
 - 3. One (1) drive shaft bearing
 - 4. Three (3) shear pins

3.02 Installation

- A. CONTRACTOR will install equipment in accordance with manufacturers' written instructions and approved submittals. Anchor bolts will be provided by CONTRACTOR.
- B. CONTRACTOR shall verify the existing shaft hole diameter opening thru the existing concrete wall for conformance with the manufacturer's requirements. The drive shaft opening in the wall shall be modified by CONTRACTOR if required by the manufacturer to accommodate his proposed shaft diameter.
- C. Provide required stainless steel anchor bolts for mounting equipment to concrete.

3.03 Manufacturer's Services

- A. Manufacturer's Field Services: CONTRACTOR shall provide the following services in addition to any other services specified herein and required by these Specifications.
 - 1. A factory trained manufacturer's representative shall be provided for a minimum of two (2) trips and a minimum of three (3) eight-hour days to provide installation supervision, start-up and field-testing services, and O&M training services. Installation services shall be coordinated between CONTRACTOR and the manufacturer. Start-up and field-testing services, and the O&M services shall be coordinated with the ENGINEER.
 - 2. After installation supervision and field-testing services by the manufacturer, CONTRACTOR shall submit to ENGINEER, a certification letter on the manufacturer's letterhead and signed by the manufacturer certifying that the equipment was installed per the manufacturer's recommendations.
 - 3. The manufacturer shall provide operator training to all required personnel.

End of Section

Division 46
Water and Wastewater Equipment

Section 46 2300

Grit Removal and Handling Equipment

Part 1 General

1.01 Scope

- A. Work described in this section includes furnishing all labor, equipment, materials, tools and incidentals required for a complete and operable installation of the grit removal system as shown on the drawings and specified herein. Manufacturer shall supply the equipment and the general contractor shall install the equipment.

1.02 Design Requirements

- A. Grit Washing and Dewatering System shall:
1. Removal efficiency, as outlined in each components section below, shall be based on the following gradation:

Percent Passing, Cumulative									
	75	106	150	212	300	425	600	1000	
North Central Regional	2.2	7.8	18.4	36.2	54.1	64.0	73.5	87.7	Physical Average
North Central Regional	2.0	13.0	41.0	62.0	84.2	91.7	95.3	97.9	SES Average

- B. The Grit Washing and Dewatering System shall be comprised of the following components:
1. SlurryCup™ Grit Washing / Classification units
 2. Grit Snail® Grit Dewatering Escalator
 3. Control Panel
- C. Grit Washing / Dewatering unit shall receive the underflow from the grit removal system. The unit shall be mounted above and discharge the concentrated and washed grit slurry to the Grit Dewatering Escalator.
- D. Grit Dewatering Escalator shall receive the underflow from the Grit Washing / Dewatering unit and allow the washed grit to settle in its integral clarifier. A slow-moving belt shall carry the grit to the point of discharge allowing it to dewater during transport. Washed and dewatered grit shall be discharged to a dewatering grit receptacle complete with drain supplied by OWNER. De-gritted overflow shall be discharged upstream of the primary grit removal equipment.
- E. Grit Washing and Dewatering System and all appurtenances shall be supplied by a single supplier.
- F. System to be furnished hereunder shall be made by a Manufacturer regularly engaged in such work and who has furnished similar installations and had them in successful and continuous operation for a minimum period of ten years.

- G. Data on performance testing, service history and operation of existing installations using the submitted equipment shall be made available to the Engineer, upon request, for use in determining that the Grit Washing and Dewatering System offered meets the intent of the contract, performance requirements and criteria stated in these specifications.
 - 1. Grit screw classifiers, grasshoppers, reciprocating rakes and similar type of units shall not be accepted.
 - 2. Units using Apex valves shall not be accepted.
 - 3. Equipment using paddles or air to supplement or induce a vortex shall not be accepted.

1.03 Submittals and Operation and Maintenance Manuals

- A. Submittals shall be provided in accordance with the General Conditions and shall include the following:
 - 1. Manufacturer's catalog data and descriptive literature including equipment weights and performance data.
 - 2. General arrangement and dimensional drawings of the grit removal system.
 - 3. Written recommended procedures for job site storage, handling, and installation of the equipment.
 - 4. Hydro International's Intellectual Property licensing agreement.
- B. Operation and maintenance manuals shall be provided at the completion of the job and in accordance with the General Conditions. The manuals shall include the following data:
 - 1. Alignment, adjustment, and repair instructions.
 - 2. Manufacturer's installation instructions.
 - 3. Assembly diagrams.
 - 4. Troubleshooting guide.
 - 5. Lubrication instructions.
 - 6. Recommended spare parts lists and predicted life of parts subjected to wear.

1.04 Quality Assurance

- A. Warranty:
 - 1. Any product that proves defective in material, workmanship or design within twelve (12) months after delivery shall be, at the discretion of the Manufacturer, modified, repaired or replaced, or Buyer's payment for the products shall be refunded. This shall be Buyer's sole remedy.
- B. Certificate of Compliance:
 - 1. The Manufacturer shall warrant that the Grit Washing and Dewatering System to be supplied shall be manufactured in strict compliance with the Contract Specifications.
- C. System shall be furnished by a Manufacturer who is ISO 9001:2008 Certified.

- D. Manufacturer shall be successful in the experience of manufacture, operation, and servicing of grit washing and dewatering systems of type, size, quality, performance, and reliability equal to that specified for a period of not less than ten (10) years. The Manufacturer shall submit evidence of experience having supplied a minimum of ten (10) installations in North America of similar size to the proposed system.
- E. In the absence of verifiable experience, the Manufacturer shall be required to provide an extended warranty and subsequent Performance Bond for the same number of years that the Manufacturer was found lacking in experience from the specified ten (10) year period. The performance bond shall commence with acceptance of the equipment and time described herein and beyond the standard warranty period.
- F. If equipment other than that shown on the Drawings is submitted to the Engineer for consideration as an equal, it shall be the responsibility of the Manufacturer requesting approval to submit with the request a revised design and layout of the mechanical equipment acceptable to ENGINEER. Revised drawings shall show the proposed location of the alternate unit, and area required for withdrawal space of replacement or serviceable components. This drawing shall also show clearances of adjacent equipment and service area required by that equipment.
 - 1. Changes in architectural, structural, electrical, mechanical and plumbing requirements for the alternate shall be the responsibility of the Manufacturer requesting approval. This shall include the cost of redesign by affected designers. Any additional cost incurred by affected subcontractors shall be the responsibility of the Manufacturer and not OWNER.

1.05 Manufacturer

- A. Grit Washing and Dewatering System shall be manufactured by Hydro International, Hillsboro, OR. 2925 NE Alcolek Drive #140, Hillsboro, Oregon, 97124, telephone 503-615-8130.
- B. Alternate Manufacturers shall require ENGINEER's written approval 20 days prior to bid opening.

Part 2 Products

2.01 Grit Washing/Classification Unit

- A. Design Data
 - 1. Number of Units: 2
 - 2. Size: 32" diameter
 - 3. Performance: 95% removal of all grit (specific gravity 2.65)
≥ 75 microns in the flow range
 - 4. Influent Solids Concentration: ≤ 1.0 %
 - 5. Design Flow/Unit: 250 gpm with 184 " of headloss
 - 6. Minimum Flow/Unit: 210 gpm with 130 " of headloss
 - 7. Maximum Flow/Unit: 320 gpm with 302 " of headloss
 - 8. Influent Connection: 6" flanged pipe

- | | | |
|-----|---------------------------|---|
| 9. | Effluent Connection: | 8" flanged pipe |
| 10. | Underflow Connection: | 3" NPT pipe |
| 11. | NPW Connection: | 1.5" NPT |
| 12. | Material of Construction: | 304 SS |
| 13. | Operation: | Continuous / Intermittent minimum 10-15 minutes |

B. Operation:

1. Grit Washing / Classification unit shall be designed to handle grit slurry underflow from the Grit Concentrator.
2. Grit Washing / Classification unit shall be characterized by a dominant, strong free vortex which utilizes centrifugal and gravitational forces and secondary boundary layer velocities to effect the separation, collection and classification of grit from the unit's inflow.
3. Defining characteristics of the dominant free vortex / secondary boundary layer velocity type units are as follows:
 - a. Dominating increasing tangential velocity profile toward the center of the unit.
 - b. The ability to handle increasing flows with no loss of the specified grit removal efficiency and with increasing headloss requirements.
 - c. The ability to classify (wash) the grit from lighter organic material to meet the specified organic solids content.
 - d. No requirements for electrical or mechanical components, flow deflecting / guiding weirs or baffles, or compressed air lines within the unit to meet the specified performance.
 - e. Continuous removal of washed, clean grit.
4. Grit Washing / Classification unit shall be all-hydraulic with no moving parts within the unit.
5. Grit underflow from the Grit Washing / Classification unit shall be transported by gravity to the Grit Dewatering Escalator unit.
6. Fluidizing Water shall be continuously supplied to the Grit Washing / Classification unit.

C. Construction:

1. Grit Washing / Classification unit shall be fabricated from stainless steel. The dished and flanged heads shall be 1/4 inch thick. The vessel walls shall be 3/16 inch thick.
2. A coating of Belzona 1811 shall be applied to the inside bottom part of the Grit Washing / Classification body to add a secondary layer of abrasion resistance.

3. Grit Separation / Classification unit shall be designed to withstand a maximum working pressure of 14.7 psig. The actual maximum pressure at the inlet shall be no more than 14.7 psig.
4. A minimum 18-inch diameter access shall be provided in the top of the Grit Washing / Classification unit. All internal elements shall be removable from inside the unit.
5. Grit Washing / Classification unit shall be free standing on three legs and mounted above a Grit Dewatering Escalator unit. Clearance shall be provided between the bottom of the grit underflow pipe and the Dewatering Unit clarifier surface.
6. Grit Washing / Classification unit shall include a Hydraulic Valve (HV) to deliver a continuous flow of "washed" grit slurry to the dewatering unit. The HV shall have no mechanical or moving parts.
7. Grit Washing / Classification Unit shall have a single 1-1/2-inch NPT pipe stub for connection of the system water.
8. The unit shall have one (1) 1.5" grit underflow connection, one (1) 3" threaded drain connection and one (1) 1.5" NPT fluidizing water connection for the Hydraulic Valve supply and Hydraulic Valve backwash.

D. Valves and Accessories:

1. Grit Washing / Classification Unit shall be supplied with the following equipment to regulate and automate the system water supply:
 - a. One (1) 1.5" bronze ball valve for utility water supply shut off.
 - b. One (1) 1.5" bronze globe valve to regulate water flow to the HV
 - c. One (1) 1.5" NEMA 7 brass solenoid valve to automate system water to the HV
 - d. One (1) 1.5" NEMA 7 brass solenoid valve to automate system backwash water
 - e. One (1) 0-100 psig pressure gauge to monitor the supply water delivery pressure.
 - f. One (1) 0-30 psig pressure gauge (Pd) to monitor the pressure in the grit slurry discharge (underflow) line.
 - g. One (1) 0-30 psig pressure gauge (Pi) to measure the inlet pressure to the Grit Washing / Classification unit.
 - h. Three (3) 1/4" bronze ball valves to isolate the pressure gauges
 - i. One (1) 3.5-35 gpm SS flow meter

2.02 Grit Dewatering Escalator

A. Design Data

1. Number of Units: 1

2. Maximum Grit Load: up to 2 cy/hr
3. Performance: 95% removal of all grit (specific gravity 2.65)
≥ 75 microns (Grit in the dumpster shall contain less than
15% volatile solids and greater than 60% total solids)
4. Belt Width: 12"
5. Clarifier size: 72" square
6. Min. Free Water Surface area: 17.3 ft²
7. Motor: 0.33 hp, XPFC
8. Overflow Connection: 6" flanged pipe
9. Drain Connection: 3" flanged pipe
10. NPW Connection: 1" NPT
11. Body Material: 304 SS
12. Belt Material: Neoprene Rubber, re-enforced with Polyester and Aluminum
13. Model Number: GS1272

A. Operation:

1. Grit Dewatering Escalator unit shall be designed to capture and dewater concentrated, washed grit slurry from the Grit Washing / Classification unit.
2. Grit Dewatering Escalator unit clarifier shall be designed based on a settling rate not to exceed 3.2 gpm/ft².
3. The tailroll mechanism shall be self-cleaning. As the belt rotates with the tail roll at the bottom of the unit the belt cleats shall lift from the belt to provide a gap of at least a 1-inch. Grit Dewatering Escalator unit belt shall be provided with 2" openings to allow transfer of fine solids internal to the belt to the underside of each cleat. Tail roll shall be fitted with a scraper, which shall also function as an internal belt scraper.

B. Construction:

1. Grit Dewatering Escalator shall be provided with an integral square clarifier which shall provide at least 3 inches of freeboard.
2. Housing for the Grit Dewatering Escalator belt shall be fitted under the clarifier. The housing for the Grit Dewatering Escalator belt shall be stainless steel with urethane bonded to the internal surfaces. The belt housing shall be inclined at 30 degrees.
3. Belt housing shall be provided with clean out plates and one (1) flanged drain.
4. Grit Dewatering Escalator unit shall be supplied with a belt made of 1/8-inch x 1/32-inch two-ply polyester reinforced continuous conductor belting. The belt cleats shall be 3-3/8" X 4-9/16" of molded 60 Durometer neoprene and aluminum reinforced and shall be vulcanized on the belt. The cleats shall attach to the belt with minimum 5/32-inch-thick neoprene hinges.

5. Dewatering Escalator unit shall be provided with a 9-3/4-inch diameter lagged headroll. Headroll shall be adjustable to allow take-up of slack in the Grit Dewatering Escalator belt. Adjustment of the headroll shall not affect the headroll retainer plate, scraper, or drive unit.
6. Grit Dewatering Escalator unit shall be provided with a headroll scraper having 1/4-inch-thick high-density polyethylene (HDPE) contact surfaces with a 1/4 inch thick HDPE retainer plate. Both retainer plate and scraper shall be loaded to keep belt cleats closed tightly around the headroll during operation.
7. Grit Dewatering Escalator unit shall be provided with a tailroll designed to mount internally to the unit belt housing with external sealed bearings.
8. Grit Dewatering Escalator unit support structure shall be as shown on the general arrangement drawing and anchored to a stable base.
9. Grit Dewatering Escalator unit shall be supplied with a factory installed rinse bar system. The system shall include:
 - a. Two spray bars located above the belt and below the clarifier liquid level to enhance grit washing.
 - b. One spray bar located at the bottom of the clarifier as a tailroll area rinse.

C. Drive Unit:

1. Grit Dewatering Escalator shall be provided with a drive unit consisting of the motor and the helical gear reducer, mounted as a single integrated unit. All Bearings shall be anti-friction, ball, or roller type bearings.
2. Motor shall be 3 phase, 460 VAC, 60 Hz, NEMA Design B, XPFC enclosure.
3. Helical gear reducer shall have hardened alloy steel gears accurately cut to shape.
4. A mechanical torque-limiting clutch shall be mounted on the headroll gear assembly to prevent an accidental overload of the drive unit and belt.
5. Drive speed shall be adjusted by a variable speed drive housed in the control enclosure. The belt speed shall be adjustable from 1-5 ft/min.

D. Valves and Accessories:

1. Grit Dewatering Escalator unit shall be supplied with the following valves:
 - a. One (1) 3" eccentric cast iron plug valve located on the unit drain.
 - b. One (1) 1" NEMA 7 brass solenoid valve to automate the water to the rinse bar system.
 - c. Two (2) 1" bronze ball valves to manually shut off flow to the rinse bar system.
 - d. One (1) 1" bronze globe valve to manually regulate flow to the tailroll spray bar.
 - e. One (1) 3/4" bronze ball valve to manually shut off the top rinse bars.
 - f. One (1) 1-10 gpm acrylic flow meter

2. Grit Dewatering Escalator unit shall be supplied with one (1) motion sensor installed on the side of the Grit Dewatering Escalator unit to detect movement of the headroll scraper arm.

2.03 Controls and Instrumentation

A. Control Panel:

1. One (1) control panel shall be furnished, completely pre-wired and tested.
2. Control panel shall adhere to the following specifications:
 - a. Enclosure Rating: NEMA 4X
 - b. Material: 304 SS
 - c. Voltage: 480 Volt
 - d. Phase: 3 Phase
 - e. Frequency: 60 Hz
 - f. Load: TBD
 - g. PLC Manufacturer: Allen Bradley
3. Control panel shall contain a PLC, all timers, VFD, switches, indicator lights, and other components necessary to operate the following equipment:
 - a. Two (2) Grit Washing / Classification units
 - b. One (1) Grit Dewatering Escalator
4. Control panel shall be supplied with a Transformer with 480-volt primary winding and 120-volt secondary winding with fused secondary.
5. Control panel shall be supplied with applicable control relays and time delay relays with a minimum one extra normally closed and one extra normally opened contact is provided for each relay.
6. Where remote monitoring is required, the panel shall be provided with all dry contacts necessary. In addition, the PLC shall be provided with an ethernet to fiber optic switch for communication with the Plant SCADA system.
7. Fiber Optic to Ethernet Converter: Ethernet switch with enough ports for the Classifier Equipment plus two additional ports, one (1) for connection of the make-up air unit, and one (1) spare shall be provided.
8. Panel door layout shall include the following items:
 - a. Front panel mounted combination main disconnect switch and circuit breaker
 - b. Back lit, push-to-test Power On indicating light
 - c. System three position HOA switch
 - d. System Emergency Stop push button
 - e. System Alarm Reset push button
 - f. Grit Separation / Classification three position HOA switch
 - g. Grit Separation / Classification supply water three position HOA switch.

- h. Grit Separation / Classification backwash water valve three position HOA switch
- i. Grit Separation / Classification auxiliary backwash pushbutton
- j. Grit Separation / Classification RUNNING indicating light
- k. Grit Separation / Classification supply valve OPEN light
- l. Grit Separation / Classification backwash valve OPEN light
- m. Grit Separation / Classification BLOWDOWN light
- n. Grit Separation / Classification WET/DRY/REMOTE three position switch
- o. SYSTEM BLOWDOWN three position HOA switch
- p. Grit Dewatering Escalator running light
- q. Grit Dewatering Escalator three position HOA switch
- r. Grit Dewatering Escalator fail indicating light
- s. Grit Dewatering Escalator manual STOP push button
- t. Grit Dewatering Escalator manual START push button
Grit Dewatering Escalator manual speed potentiometer
- u. Grit Dewatering Escalator rinse water valve three position HOA switch
- v. Grit Dewatering Escalator rinse water valve OPEN indicating light
- w. Grit Dewatering Escalator FAIL RESET push button
- x. Grit Dewatering Escalator LOCAL/REMOTE switch for escalator speed control
- y. Grit Dewatering Escalator INTERMITTENT/CONTINUOUS switch

B. Local Control Panel:

- 1. One (1) NEMA 7, local control E-stop and HOA station shall be furnished, completely pre-wired and tested.

2.04 Accessories

A. Ladder/Walking Platform.

- 1. An access ladder and platform shall be provided to provide access to the slurry cups for maintenance purposes. The ladder/platform shall be constructed of galvanized steel and shall meet all applicable Building and OSHA codes for loading/fall protection. The basic dimensions/configuration of the platform shall be as shown on the Drawings.

2.05 Sequence of Operation

- A. System shall be controlled to provide automatic or manual operation, manual starting and stopping, and system shut down when a fault is detected. The system shall be able to be started and controlled remotely from the plant SCADA system via Ethernet connection to the control panel.
- B. Grit Washing / Classification Unit:
 - 1. Underflow from the grit removal system shall be pumped to the Grit Washing / Classification continuously.
 - 2. During operation, a small volume of washed/classified grit slurry shall continuously underflow from the Grit Washing / Classification unit. Control of the grit slurry underflow rate is via the HYDRAULIC VALVE mounted on the bottom of the unit. A portion of the system water is continuously introduced to the HYDRAULIC VALVE.
 - 3. Periodically, (typically twice per hour during heavy grit loads and typically once per hour during light grit loads), a backwash sequence is initiated, by cycling solenoid valves, which flushes the grit underflow gap inside the unit. Frequency and duration of backwash cycles is adjustable.
 - 4. Periodically, (typically once every 4 backwashes), a blowdown sequence is initiated to flush accumulations of debris inside the unit. Blowdown is accomplished by stopping the influent to the Grit Washing / Classification unit, cycling solenoid valves, and resuming operation. Frequency and duration of blowdown cycles is adjustable.
- C. Grit Dewatering Escalator Unit:
 - 1. Grit Dewatering Escalator belt shall run in CONTINUOUS operation with the water and belt running constantly. In INTERMITTENT operations the belt will run off and on using adjustable timers. When the belt stops, the water solenoid Valve closes with a default run time of 5 minutes. The default stop time is 15 minutes.
 - 2. While the dewatering unit is running, water shall be directed to the tail roll self-cleaning mechanism and grit rinse system.
 - 3. The belt speed shall be adjustable via a manual speed control potentiometer on the control panel or by remote signal (4-20ma) from the plant DCS.
 - 4. A motion sensor shall be installed on the side of the Grit Dewatering Escalator take up frame and shall detect movement of the head roll scraper arm. Lack of motion of the head roll scraper arm shall indicate lack of belt movement, drive unit failure and/or scraper arm overload. Lack of belt movement or scraper arm overload shall interrupt signal from the motion sensor to the timer. If the motion sensor fails to reset the timer, the Grit Dewatering Escalator shall stop and the failure light illuminate.
 - 5. After a System Shut Down, the Grit Dewatering Escalator shall continue to operate for a pre-determined amount of time to allow for the removal and dewatering of all grit accumulated in the clarifier. The off-delay timer shall be adjustable from 0-60 minutes with a typical delay off time of 15 minutes.

2.06 Utility Requirements

A. Water:

1. Grit Washing / Classification Unit and Grit Dewatering Escalator combination shall require clarified non-potable water supplied at a regulated 50 psig \pm 5 psi. Water requirements are as follows:
 - a. A continuous supply of 30 gpm is required for normal operation of each Grit Separation / Classification unit.
 - b. An intermittent supply of 47 gpm is required for a periodic short duration during backwash cycle for each Grit Separation / Classification unit.
 - c. A continuous supply of 10 gpm for normal operation of the Grit Dewatering Escalator unit.

B. Electrical:

1. System shall require one (1) 480 VAC, three phase electrical service connection to operate.

2.07 Materials and Finishes

A. Materials:

1. All stainless steel used for the fabrication of the equipment shall conform to the following standards:
 - a. Plate and Sheet ASTM A 167
ASTM A 240
 - b. Bar ASTM A 276
ASTM A 479
 - c. Tube ASTM A 312

B. Exterior Surfaces Finishes

1. Surfaces shall be free of sharp edges, weld spatter and residue. All welds shall be ground smooth.
2. Stainless steel surfaces shall be acid washed.
3. Non-submerged exterior surfaces shall be Glass Bead Blasted to a uniform finish.

Part 3 Execution

3.01 Delivery and Installation

- A. Equipment and material shall be shipped complete except where partial disassembly is required by transportation regulations or for protection of components.
- B. Spare parts shall be packed in containers bearing packing lists clearly designating contents and pieces of equipment for which they are intended.

- C. CONTRACTOR shall inspect equipment prior to unloading and notify the Manufacturer of any damage to equipment within 5 days to effect proper remedial action. Failure to notify the Manufacturer of damage to equipment prior to unloading shall void all warranties pertaining to subject equipment.
- D. CONTRACTOR shall unload, store and safeguard equipment, materials, and spare parts in accordance with Manufacturer's recommendations.

3.02 Start-Up, Training and Manufacturer's Services

- A. A factory trained representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the Owner for a maximum of (4) 8-hour man-days (2 visits) for installation inspection, plant startup, functional testing, and operator instructions; travel time excluded. A minimum of 30 days' notice is required to schedule Manufacturer's services. Any services with less than 30 days' notice shall be billed for service time and actual travel costs.

3.03 Functional Testing

- A. Prior to plant startup, all equipment shall be inspected for proper alignment, operation, connection, and satisfactory operation by means of a functional test. It is the General Contractor's responsibility to duly notify the Manufacturer of any inabilities to perform functional testing prior to operator training.

3.04 Manufacturer's Certificate(s)

- A. Provide Manufacturer's certificate of installation and commissioning following functional testing and startup.
- B. Provide Manufacturer's OEM Software Licensing Agreement following acceptance and final payment.

3.05 Spare Parts

- A. One (1) set of bearings, one (1) set of gaskets and one (1) drive chain.

End of Section

Section 46 5111.13

Fixed Header Aeration System

Part 1 General

1.01 Scope

- A. Furnish all materials and equipment for the fixed header aeration systems in the Battery A grit tanks.
- B. Furnish all equipment as shown on the drawings and as specified herein.
- C. Provide services and testing associated with the equipment.
- D. Items furnished by the equipment supplier under this section are for installation by CONTRACTOR.

1.02 Equipment Components Included

- A. Stainless steel dropleg, distribution header(s) and diffusers.
- B. Stainless steel manifold and supports
- C. Stainless steel supports and anchor bolts.
- D. Stainless steel flanged and expansion joints.
- E. Bolts, nuts and gaskets for aeration system flange connections.

1.03 Submittals

- A. Submit information to establish compliance with the specifications in accordance with the provisions of Section 01 3300 Submittals.
- B. Submittal drawings showing plan, elevation and cross sections of the equipment.
- C. Component details of the aeration equipment showing diffusers, diffuser connectors, supports, expansion joints and flanges.
- D. Materials and manufacturing specifications.
- E. Equipment booklet to include:
 - 1. Equipment data sheets
 - 2. Performance data including oxygen transfer calculations.
 - 3. Head loss calculation and pressure requirements.
 - 4. Descriptive literature and bulletins.
 - 5. Customer contact list with telephone numbers (minimum of 10 contacts from similar size facilities).
 - 6. Operation and maintenance manual with installation instructions. Submit after approval of equipment and prior to shipment.
 - 7. Detailed list of any or exceptions taken to these specifications. Include specification reference and proposed alternative with reason stated for exception.

1.04 System Design and Performance

- A. Design Conditions. Average flow rate thru each of the two Battery A grit tanks shall be 80 scfm. Peak flow rate shall be 150 scfm. Provide even distribution of flow along entire tank length. Provide separate air zone (with separate air shutoff valve) along effluent weir consisting of 10% of the total tank airflow.

Part 2 Products

2.01 Acceptable Manufacturers

- A. Sanitaire Division of Xylem, Inc., Brown Deer, Wisconsin

2.02 Materials, Fabrication and Finishing

- A. Stainless Steel
 - 1. Fabricate all welded parts and assemblies from sheets and plates of 304L stainless steel with a 2D finish conforming to ASTM A240.
 - 2. Fabricate non-welded parts and flanges from sheets, plates or bars of 304 stainless steel conforming to ASTM A240 or ASTM A276.
 - 3. Provide droplegs, manifolds and headers of the diameter shown on the drawings with dimensional tolerances conforming to ASTM A554 and fabrication procedures in accordance to ASTM A774 & A778.
 - 4. Furnish air distribution headers with the following minimum nominal wall thicknesses.
- B. For gusset-reinforced diffuser connectors and header systems as specified in Section 2.05.

Header Diameter (Inches)	Wall Thickness (Inches)
4 Thru 18	0.109

- C. For diffuser connectors and headers that are not gusset reinforced as specified in Section 2.05, the minimum allowable header wall thickness is 0.25 inches to minimize potential for connector failure.
- D. Furnish diffuser connector from cast 316L Stainless Steel.
- E. Furnish all flanges from stainless steel per paragraph 2.02.A.2.
- F. Furnish all nuts, bolts and washers including anchor bolts in 18-8 series stainless steel.
- G. Furnish 304L stainless steel diffusers conforming to the material as listed in paragraph 2.02.A.1, 2, and 3 with a cast 304L Schedule 80 threaded inlet nozzle.
- H. Welds & Welding Procedure:
 - 1. Weld in the factory with ER 316L filler wire using MIG, TIG or plasma-arc welding inert gas processes. Provide a cross section equal to or greater than the parent metal.

2. Provide full penetration butt welds to the interior surface with gas shielding to interior and exterior of joint.
3. Provide smooth, even distribution interior weld beads with an interior projection not exceeding 1/16 inch beyond the I.D. of the air header or fittings.
4. Continuously weld both sides of face rings and flanges to eliminate potential for crevice corrosion.
5. Field welding is NOT permitted.

I. Corrosion Protection and Finishing:

1. Clean all welded stainless steel surfaces and welds after fabrication by using the following procedure:
 - a. Pre-clean all outside weld areas to remove weld splatter with the use of stainless steel brushes and/or deburring and finish grinding wheels.
 - b. Finish clean all interior and exterior welds and piping by full immersion pickling and rinse with water to remove all carbon deposits, oxide film and contaminants to regenerate a uniform corrosion resistant chromium oxide film.
 - (1) Completely immerse all stainless steel assemblies and components in an acid solution as described in Section 6.2.11 of ASTM A380-88. The acid shall be a nitric-hydrofluoric solution as defined in Table A.2.1 of Annex A2 of ASTM A380.
 - (2) Provide a final thorough rinse using ordinary industrial or potable water and dry in conformance per Section 8.3 of ASTM A380.
 - c. Corrosion protection techniques not utilizing full immersion methods are unacceptable and will be cause for rejection of the equipment.
 - d. ENGINEER/OWNER at their option may choose to observe the equipment cleaning procedure by notifying the manufacturer of their intent to visit thirty (30) days prior to the date. Cost of the travel and expenses are the responsibility of OWNER.
 - e. Neoprene – furnish all gaskets of fiber reinforced neoprene – 45 to 50 durometer (Shore A).

2.03 Fixed Aeration Headers, Manifold and Droplegs

- A. Provide a dropleg from the air main connection or air control valve to the aeration system as shown on the drawings.
 1. Provide a stainless steel Van Stone style flange design with a 150 pound drill pattern flange ring for the top connection.
 2. Provide a stainless steel band clamp coupling with gasket for the lower dropleg to header connection for ease of installation and alignment.

- B. Fabricate manifold and air distribution headers in sections up to 41 feet in length.
 - 1. Provide expansion joints consisting of a welded flanged expansion barrel, "O" ring gasket, "O" ring locking flange and hardware to accommodate +2 inch of movement.
 - 2. Provide eccentric reducers for changes in diameter for constant invert elevation.
 - 3. Provide 8-inch diameter and smaller headers with removable end caps and 10-inch diameter and larger headers with welded end caps.
- C. Join sections of manifold or air distribution headers with flanged joints or expansion joints. Design individual header sections for rotation independent of adjacent sections for alignment purposes during installation.
 - 1. Provide flanged joints consisting of face rings, rotating ring flanges, bolts and gaskets.
 - 2. Provide expansion joints consisting of a welded flanged expansion barrel, "O" ring gasket, "O" ring locking flange and hardware to accommodate +2 inch of movement.
- D. Furnish expansion/contraction system for all headers designed for temperature range of 125 degree Fahrenheit consisting of simple and fixed supports and expansion joints.
 - 1. Lengths of header can extend up to 80 feet from restraining point without an expansion joint.
 - 2. Limit maximum distance between restraining points on a continuous length of header to 120 feet maximum.
 - 3. Provide an expansion joint on continuous lengths of header between two restraining points.
 - 4. Provide simple supports to restrain header from buoyant uplift forces in compliance with Section 2.04.
 - 5. Provide fixed supports in compliance with Section 2.04.
 - 6. Limit movement to prevent expansion joint blow apart and transmit expansion forces from the header to the fixed support stand.
 - 7. Provide a mechanical link to connect the header and fixed support stand.
 - 8. Reinforce the header at the attachment point of the mechanical link.

2.04 Supports and Anchor Bolts

- A. Provide each section of air header with a minimum of two supports with the maximum spacing between supports not to exceed 17 feet.
- B. Limit header or manifold cantilever to no more than 4 feet.
- C. Provide header supports with a vertically adjustable header hold down locking mechanism mounted on a stainless steel supporting structure.

- D. Provide header supports with a vertically adjustable header hold down locking mechanism mounted on anchor bolts cast into 4000 PSI reinforced concrete pedestals.
- E. Design support hold down locking mechanisms with a minimum width of 2 inch and a minimum thickness of .109 inch on headers 12-inch diameter or smaller.
- F. Design support hold down locking mechanisms using a "U" bolt smaller diameter and larger.
- G. Provide supports with a mechanism to provide for +2 inch of vertical adjustment and + 1/2 inch of lateral adjustment for alignment of the header in the field.
- H. Provide a wall or floor mounted support near the drop pipe to header connection for vertical support and restraint of movement due to thermal expansion and to prevent blowing apart.
- I. Anchor Bolts
 - 1. Design anchor bolts for embedment in 4000 psi concrete with a pullout safety factor of 4.
 - 2. Attach supports to the tank with two stainless steel anchor bolts.
 - 3. Provide a mechanical stainless steel expansion type anchor bolt system.
 - 4. Provide a chemical bond adhesive stainless steel anchor bolt system with stainless steel threaded stud bolts.

2.05 Air Diffusers

- A. Provide diffusers fabricated of stainless steel material – refer to Section 2.02 Materials, Fabrication and Finishing.
- B. Design diffuser for operating range of 8 to 40 SCFM.
- C. Design diffusers with cast Schedule 80 3/4-inch NPT threaded nozzle and acetyl orifice insert if required, an inverted air reservoir, air exit ports and a full-length deflector.
 - 1. Design diffusers to provide full wide band aeration with a minimum air release perimeter of 48 inches per diffuser. Release air uniformly along a minimum 2-foot band beyond each side of the header.
 - 2. Locate exit ports discharging air into liquid on horizontal planes at two levels.
- D. Diffuser Deflector
 - 1. Provide deflector below each diffuser for its full length and width.
 - 2. Design deflector to direct the liquid being aerated along the diffuser reservoir walls so that the air exits through the ports and is sheared into small bubbles and distributed into the liquid.

Part 3 Execution

3.01 Installation Procedure

- A. Follow equipment manufacturer's recommendations for sequencing of equipment installation.
- B. Layout and install support anchors in accordance with equipment manufacturer's recommendations and anchor setting plan.
- C. Level aeration system such that all diffusers connected to a header are within plus or minus 3/8-inch of a common horizontal plane.

3.02 Installation/Start Up Services

- A. Provide services of a factory representative to verify the proper installation of the equipment.
- B. Provide services of a factory representative to instruct OWNER's personnel on operation and maintenance.
- C. Minimum onsite time of 1 trip, 1 day for installation verification and startup.

3.03 Spare Parts

- A. Furnish two (2) diffusersx
- B. Package spare parts in a separate container clearly marked as "Spare Parts" and provide inventory list on exterior of the container.

3.04 Warranty

- A. Warrant all parts to be free from defects in materials and workmanship for a period of one year after installation or 18 months after delivery, whichever occurs first.
- B. Furnish replacement parts to OWNER for any items found to be defective within the one-year warranty period.

End of Section

Exhibit 1

Project Forms

1. Certificate of Substantial Completion
2. Change Order
3. Change Proposal
4. Construction Change Requisition / Work Change Directive
5. Field Order
6. Non-Compliance Notice / Order to Remove Defective Work
7. Open Items List
8. Punch List Items
9. Request for Final Inspection
10. Request for Information
11. Substitution Request Form
12. Warranty Data Sheet
13. City of Flint Material Disposal Form

OWNER shall have 45 days after receipt of this certificate during which he may make written objection to ENGINEER and CONTRACTOR as to any provisions of the certificate or attached list. Such objection may be cause for this Certificate of Substantial Completion to be null and void.



CHANGE ORDER NO. _____

305.08
(Rev. 04/2019)

Prepared By: _____

Date of Issuance: _____

WT Project No.:		Project Name:	
Owner / Municipality:			
Owner Project No.:		Department:	
Project Location:			
Contractor:		Subcontractor:	

The Contract Documents are modified as follows upon execution of this Change Order:

--

Attachments: (List documents supporting change):

--

CHANGE IN CONTRACT PRICE

Original Contract Price:

\$

Orders No. _____ from previously approved Change
to No. _____ :

\$

Contract Price prior to this Change Order:

\$

of this Change Order:

\$

Contract Price incorporating this Change Order:

\$

CHANGE IN CONTRACT TIME

Original Contract Times:

Working Days Calendar Days

Substantial Completion (date):

Ready for final payment (date):

Orders No. _____ from previously approved Change
to No. _____ :

Substantial Completion (days):

Ready for final payment (days):

Contract Times prior to this Change Order:

Substantial Completion (date):

Ready for final payment (date):

of this Change Order:

Substantial Completion (days):

Ready for final payment (days):

Contract Times with all approved Change Orders:

Substantial Completion (date):

Ready for final payment (date):

RECOMMENDED:

By: _____
Engineer (Authorized Signature)

Date: _____

ACCEPTED:

By: _____
Owner (Authorized Signature)

Date: _____

ACCEPTED:

By: _____
Contractor (Authorized Signature)

Date: _____

Change Order becomes effective upon date of final signature.



CHANGE PROPOSAL NO. _____

305.01
(Rev. 04/2019)

Prepared By: _____

Date of Issuance: _____

WT Project No.:		Project Name:	
Owner / Municipality:			
Owner Project No.:		Department:	
Project Location:			
Contractor:		Subcontractor:	

This Change Proposal is submitted in accordance with Paragraph 10.06 of the General Conditions.

If this Change Proposal is accepted, either in whole or in part, a Change Order will be issued to modify the Contract Documents accordingly.

Detailed Description of Proposed Change:

Attachments: (List documents attached supporting requested change):	
<p style="text-align: center;"><u>CHANGE IN CONTRACT PRICE</u> of this requested Proposal:</p> <p>\$ _____</p>	<p style="text-align: center;"><u>CHANGE IN CONTRACT TIME</u> of this requested Change Proposal:</p> <p>Substantial Completion (days): _____ Ready for final payment (days): _____</p>

Engineer's Decision on Change Proposal:

<p>ENGINEER:</p> <p>By: _____ <i>Engineer (Authorized Signature)</i></p> <p>Date: _____</p>	<p>OWNER:</p> <p>By: _____ <i>Owner (Authorized Signature)</i></p> <p>Date: _____</p>	<p>CONTRACTOR:</p> <p>By: _____ <i>Contractor (Authorized Signature)</i></p> <p>Date: _____</p>

CONSTRUCTION CHANGE REQUISITION WORK CHANGE DIRECTIVE



CONSTRUCTION CHANGE REQUISITION WORK CHANGE DIRECTIVE

No. _____

(continued)

Date: _____

Page: _____ of _____

Work Order Authorization: Approved Approved as Noted Not Approved

If authorized, the Contractor agrees to do the work outlined above under the direction of the Engineer, and to accept as payment in full the basis of payment as indicated.

Contract Time: Add Time Extension of _____ Days Not Applicable

Accepted By: _____
Contractor (Representative) _____ Date _____

Recommended By: _____
Wade Trim (Representative) _____ Date _____

Approved By: _____
Owner (Representative) _____ Date _____



FIELD ORDER NO. _____

305.04
(Rev. 04/2019)

WT Project No.:		Project Name:	
Owner / Municipality:			
Owner Project No.:		Department:	
Project Location:			
Contractor:		Subcontractor:	
Date:			
Prepared by:			
Subject / Description:			

Classification:	Clarification or Interpretation of Contract Documents
-	Minor Change in Work Which Does Not Involve Contract Price or Contract Time
	Minor Change in Addition to Work

Reason:_____
Resident Project Representative Date_____
Contractor's Authorized Representative Date



NON-COMPLIANCE NOTICE / ORDER TO REMOVE DEFECTIVE WORK NO. _____

330.06
(Rev. 01/2018)

Job No.: _____

Date: _____

Project: _____

Time: _____

Attention: _____

You are hereby notified that:

_____ does not conform to the Contract Requirements. The Specification violated in Section _____, Article _____, Drawing No. _____. Under the provisions of the Contract, the requirements are _____

Non-complying work may be required to be removed and replaced at no cost to the Owner.

Non-complying work may be removed and replaced at no cost to the Owner. No work shall continue until the defective work has been removed.

It shall be the Contractor's responsibility to determine the corrective action plan necessary to bring the work into compliance. This action plan shall be submitted to the Owner and his authorized representative for their review and concurrence that said corrective action will adequately address the deficiency. If you refute the initial findings, it is your responsibility to make your position known to the Owner and his representative with sufficient documentation that your position can be evaluated. All actions described above shall be done in writing as near to the date of the Notice as possible, but no later than ten (10) days after the issuance of said Notice.

Resident Project Representative (Signature)

Non-Compliance Notice Received By Contractor

Received On: _____
Date

By: _____
(Signature)

Title: _____

Corrective action to be taken by Contractor: _____

Date

By: _____
(Signature)

Owner's Acknowledgement

Accepted

Accepted as Noted

Unacceptable

Pricing

Date

By: _____
(Signature)

OPEN ITEMS LIST

350.01

(Rev. 01/2019)

Page: of

Construction Start Date: _____

WT Project No.:		Project Name:	
Owner / Municipality:			
Owner Project No.:		Department:	
Project Location:			
Contractor:			Subcontractor:

[illegible]

Close out of all items verified by Field Engineer: _____ **Signature:** _____ **Date:** _____

Comments:

- 1) This Open Items List is to be immediately inserted in the Inspection folder for each assignment by the assigned Inspector or the assigned Field Engineer.
- 2) Anyone can make entries on this list, but each entry must be initialed and dated. Item(s) entered must be reported to the assigned Field Engineer immediately.
- 3) Action to be taken should be confirmed with the assigned Field Engineer.
- 4) Verification for completion can be initialed and dated by the assigned Inspector but must also be verified by the assigned Field Engineer.
- 5) This form is not contractual to contract completion.



REQUEST FOR FINAL INSPECTION

350.06
(Rev. 04/2019)

WT Project No.:		Project Name:	
Owner / Municipality:			
Owner Project No.:		Department:	
Project Location:			
Contractor:		Subcontractor:	

The project to which this request applies has been inspected by authorized representatives of CONTRACTOR and ENGINEER, and the Work is hereby declared to be substantially complete to a point that a project punch list should be prepared in accordance with the following schedule:

Develop Preliminary Punch List

Date: _____

Responsibility: Owner, Contractor and Engineer
Engineer shall have 2 weeks to prepare the punch list.

Complete Preliminary Punch List Items

Date: _____

Responsibility: Contractor
Contractor shall have 2 weeks to complete the items on the punch list.

Develop Final Punch List (if needed)

Date: _____

Responsibility: Owner, Contractor and Engineer
If needed, a second and final punch list will be prepared within 2 weeks by Engineer.

Complete Final Punch List Items

Date: _____

Responsibility: Contractor
Contractor shall have 2 weeks to complete the items on the second and final punch list.

Process Final Payment

Date: _____

Engineer will have 2 weeks to review and submit final pay request documents from Contractor to the Owner for final payment upon satisfactory completion of punch list items by Contractor.

This notice signed and dated through mutual agreement of CONTRACTOR and ENGINEER will initiate the time sequence for the approved execution of finalizing _____

Contract in _____, Michigan, dated _____.

COPY: OWNER

Date: _____

ENGINEER's Representative

Date: _____

CONTRACTOR's Representative

[Contractor to
Insert logo here]

REQUEST FOR INFORMATION (RFI) NO. _____

311-01
(Rev. 04/2019)

Page: 1 of

WT Project No.:		Project Name:	
Owner / Municipality:			
Owner Project No.:		Department:	
Project Location:			
Contractor:		Subcontractor:	

RFI Subject:			
Division:		Spec Section:	
Plan Sheet No(s).:			
Date Received:		Requested Response Date:	
Returned to Contractor:			

Is there potential for effects to the Contract?

Contract Price Impact:

Contract Schedule Impact:

Information Requested

Attachments

Response**Attachments**

Response by: _____ Date: _____

THIS REPLY IS GIVEN WITH THE EXPRESSED UNDERSTANDING THAT IT DOES NOT CONSTITUTE BASIS FOR CHANGE IN PRICE OR TIME OF THE CONTRACT UNLESS OTHERWISE INDICATED.



REQUEST FOR INFORMATION (RFI) NO. _____ RESPONSE

311-01
(Rev. 04/2019)

Page: 1 of _____

WT Project No.:		Project Name:	
Owner / Municipality:			
Owner Project No.:		Department:	
Project Location:			
Contractor:		Subcontractor:	

RFI Subject:			
Division:		Spec Section:	
Plan Sheet No(s).:			
Date Received:		Requested Response Date:	
Returned to Contractor:			

REVIEWER INFORMATION

Reviewed By:	
Email:	
Phone:	

RESPONSE:

Attachments

Response by: _____ Date: _____

THIS REPLY IS GIVEN WITH THE EXPRESSED UNDERSTANDING THAT IT DOES NOT CONSTITUTE BASIS FOR CHANGE IN PRICE OR TIME OF THE CONTRACT UNLESS OTHERWISE INDICATED.



SUBSTITUTION REQUEST FORM

310.06
(Rev. 04/2019)

WT Project No.:		Project Name:	
Owner / Municipality:			
Owner Project No.:		Department:	
Project Location:			
Contractor:		Subcontractor:	

Specification Section: _____ Article No.: _____
Specified Product: _____
Proposed Substitution: _____

Does specified product exceed in any respect, proposed substitution?	Yes	No
Does substitution affect dimensions shown on Plans?	Yes	No
Does substitution affect other trades more than original product?	Yes	No
Does warranty differ from that specified?	Yes	No
Does substitution affect cost to OWNER?	Yes	No
Does substitution result in any license fee or royalty?	Yes	No

If you indicated "Yes" to any of the items above, attach thorough explanation for the following:

1. Explain any differences between proposed substitution and specified product.
2. Summarize experience with product and manufacturer in Project area.
3. Attach complete technical data and literature.

The undersigned states that the function, appearance, and quality of the proposed substitution is equivalent or superior to the specified item, and that all information above and attached is true and correct.

Submitted by: _____ Date Submitted: _____
Company: _____
Address: _____
Telephone: _____ Email: _____
Signature: _____

ACTION STATUS	
ENGINEER'S REVIEW	RESPONSE REQUIRED OF CONTRACTOR
1. Approved (A) 2. Approved as Noted (AN) 3. Revise and Resubmit (RR) 4. Not Approved - See Remarks (NA)	None Confirm Resubmit
<p>Engineer's review is for general conformance with the design concept and contract documents. Markings or comments should not be construed as relieving the contractor from compliance with the project requirements, nor departures therefrom. The contractor remains responsible for details and accuracy, for confirming and correlating all quantities and dimensions, for selecting fabrication processes, for techniques of assembly, and for performing his work in a safe manner.</p> <p>WADE TRIM</p> <p>By: _____ Date: _____</p>	



WARRANTY DATA SHEET

350.07
(Rev. 04/2019)

Date: _____
Page: _____ of _____

WT Project No.:		Project Name:	
Owner / Municipality:			
Owner Project No.:		Department:	
Project Location:			
Contractor:		Subcontractor:	
Contractor Address:		Phone:	

Project Description:

Supplier/Vendor: _____ Phone: _____
Address: _____

Manufacturer: _____ Serial No. _____

Manufacturer Part No.: _____ Asset / Part Name: _____

Location: _____ Owner ID No.: _____

Warranty Provider: _____

Warranty Type (labor, parts, parts and labor, etc.) _____

Warranty Description:

Warranty Class/Limitations: Limited 1 year 2 year
Other: _____

Warranty Date: _____ Initial Reading: _____

Warranty Expiration Date: _____ Maximum Reading: _____

Exclusions:

Comments:

Attachment: Copy of Warranty



THE CITY OF FLINT, MI

MATERIAL DISPOSAL PLAN (MDP)

This form is to be submitted when removal and off-site disposal of excavation spoils, demolished material or other debris is required from a City of Flint project.

All excavated and demolished material from a construction site that is not to be reused must be properly removed and disposed at an approved facility. If the material is to be disposed of in the City of Flint, a permit or written authorization must be obtained from the City. If it is to be disposed of outside the City limits, documentation must be provided that the Contractor has complied with all the rules and regulations of the local community and that the disposal facility or property owner has given their approval to accept the material. One copy of this form must be completed for each disposal / stockpile site if the Contractor plans to use more than one site. A copy of this plan must be on file with the City and Engineer before initiating construction.

General Project Information and Certification

Date Submitted: _____ City of Flint Project No: _____

Contractor: _____ Project Name: _____

In submitting this Material Disposal Plan (MDP), the above named contractor expressly certifies that all material to be removed from the construction site will be hauled in accordance with all applicable federal, state, and local highway and traffic rules, regulations and laws, and that the Material Disposal Plan meets all federal, state, and local rules and regulations with regard to the removal and disposal of this material.

Contractor Contact: _____

Title: _____

Signature: _____

Date: _____

Disposal of Material within the City of Flint

Is the material to be disposed of within the City of Flint?

Yes¹ _____ No _____

'Attach a copy of the disposal permit if the above answer is "Yes".

Disposal of Material outside of the City of Flint

Is the material to be disposed of outside of the City of Flint?

Yes² _____ No _____

'Provide the following information if material is to be removed from the site and disposed outside the City of Flint.

Disposal Site: _____

Site Address: _____

Municipality: _____

Is a permit for the above municipality required?

Yes³ _____ No _____

Attach a copy of the municipal permit

Directions to Site _____

Disposal Facility / Property Owner Acknowledgement

I hereby acknowledge that I have agreed to accept material from _____, to be disposed of at our facility / property as described above and that it is my understanding that the above named contractor will meet all federal, state, and local rules and regulations with regard to the removal and transport of this material.

Facility Owner: _____ Title: _____

Signature: _____ Date: _____

Exhibit 2
Geotechnical Report

GEOTECHNICAL EXPLORATION

Report on:

**Geotechnical Exploration
Proposed Dewatering Building
Flint Wastewater Treatment Plant
Flint, Michigan**

Prepared For:

Wade Trim Inc.
555 S. Saginaw Street, Suite 201
Flint, Michigan 48502

GeoTran Project No.: 17-09002G-10
February 8, 2018

GeoTran

**10315 E. Grand River
Suite 201
Brighton, Michigan 48116**

Mr. Jeremy Schrot, PE
Wade Trim Inc.
555 S. Saginaw Street, Suite 201
Flint, Michigan 48502

February 8, 2018
GeoTran Project No. 17-09002G-10

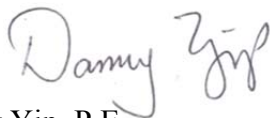
**RE: Report on Geotechnical Exploration
Proposed Dewatering Building
Flint Wastewater Treatment Plant
Flint, Michigan**

Dear Mr. Schrot:

We are pleased to submit this report of our geotechnical exploration completed for the proposed dewatering building project at the City of Flint Wastewater Treatment Plant in Flint, Michigan. The investigation was performed in accordance with the scope of services outlined in our September 21, 2017 E-mail correspondence to you and Subconsultant Agreement between Wade Trim Inc. and GeoTran Consultants, LLC dated September 26, 2017.

We appreciate the opportunity to be of service to you on this project. If you have any questions regarding this report or if we can be of further assistance, please feel free to contact us at (810) 229-6805.

Sincerely,
GeoTran Consultants, LLC



Danny Yip, P.E.
Project Engineer



Tanweer Shah, P.E.
Senior Project Manager

DY/TS/dy
Attachments

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3.0 CURRENT FIELD EXPLORATION	2
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APPENDIX

SITE LOCATION MAP	FIGURE NO. 1
BORING LOCATION PLAN	FIGURE NO. 2
GENERAL NOTES	FIGURE NO. 3
LOGS OF SOIL BORING	FIGURE NOS. 4 & 5
SUMMARY OF LABORATORY TEST DATA	FIGURE NO. 6
GRAIN SIZE ANALYSIS	FIGURE NO. 7

1.0 INTRODUCTION

This report presents the results of a geotechnical exploration completed for the proposed dewatering building at the City of Flint Wastewater Treatment Plant in Flint, Genesee County, Michigan. The site location, relative to existing streets and topographic features, is shown on the Site Location Map, Figure No. 1 of the Appendix.

The purpose of the investigation was to explore and evaluate the general subsurface conditions at the site and to develop foundation and related site preparation recommendations for the proposed project. Conclusions and recommendations presented in this report are based on the subsurface conditions encountered at the locations of our explorations and our current understanding of the proposed project. Conditions may vary between boring locations, and should not be extrapolated to other areas without our prior review.

2.0 SITE AND PROJECT CHARACTERISTICS

The site of the proposed project is located on the premises of the City of Flint Wastewater Treatment Plant (WWTP) located at 4652 Beecher Road in Flint. This location is near the northeast corner of the intersection of North Linden and Beecher Roads. The approximate layout of the site is presented on the Boring Location Plan, Figure No. 2 of the Appendix. As indicated on Figure No. 2, the site is located south of the existing Primary Settling Tanks and east of the Grit Tanks Nos. 1 and 2. Currently, the site is grass covered, while concrete sidewalks run along the north and west sides of the site. The topography at the site is relatively flat with site ground surface elevation presumed to be on the order of about 717 feet. Flint River bounds the WWTP approximately 800 feet northeast of the site.

Based on our visual field observations, review of yard piping drawing and utility staking markings, underground utilities such as plant influent piping, drains, tunnels, forced mains, sewers, water or electric lines and/or other unknown below-grade utilities are assumed to exist near the site, but were not encountered during this investigation.

We understand that the City of Flint has contracted with Wade Trim, Inc. (Wade Trim) to prepare design plans for the project. Based on the information provided, it is our understanding that the project calls for construction of a one-story slab-on-grade dewatering building with plan dimensions anticipated on the order of 20 feet by 30 feet. The proposed building is presumed to house presses, pumps, piping and other equipment. The structural loads associated with the new building are not currently known to us; however, for purposes of this report, we have assumed the loads will be light to moderate.

3.0 CURRENT FIELD EXPLORATION

Subsurface conditions at the site were explored by drilling two exploratory soil borings, designated as B-1 and B-2, at the approximate locations shown on the Boring Location Plan, Figure No. 2 of the Appendix. The soil borings were located in the field by GeoTran representative by referencing to existing site features. B-1 was located near the northeast corner and B-2 near the southwest corner of the proposed building footprint. The borings were not surveyed by a licensed land surveyor; therefore, the locations shown on Figure No. 2 are considered to be approximate. Likewise, site ground surface elevations at the boring locations were estimated from the topographic information provided to us by Wade Trim and should be considered approximate as well.

The soil borings were machine-drilled by DLZ/American Drilling under the full-time technical observation of a field engineer with our firm. The borings were drilled using a CME 75 truck-mounted drilling rig and completed to a depth of about 39 feet each below existing ground surface. Continuous flight, hollow-stem augers having an inside diameter of 2¼ inches were used to advance the borings to the explored depth. It is noted that Boring B-2 was offset from its initial location due to a concrete obstruction encountered at the initial location at a depth of about 5½ feet (initial B-2 location approximately 10 feet southwest of its final as-drilled location).

Within the borings, soil samples were obtained at intervals of 2½ feet within the upper 10 feet and at intervals of 5 feet below that depth. In general, the samples were obtained using a 1⅜-inch inside-diameter split-barrel sampler and the Standard Penetration Test (SPT) method ASTM D 1586, described on the attached General Notes, Figure No. 3. Soil samples obtained from the borings were visually classified in the field by our representative using Unified Soil Classification System (USCS), sealed in containers and transported to the laboratory for further classification and testing. We will retain these samples for 60 days after the date of this report. At that time, we will dispose of the samples unless we are otherwise instructed.

Upon the completion of drilling and sampling operations, and following subsequent groundwater observations, the soil borings were backfilled using excavated materials.

4.0 LABORATORY TESTING

Representative soil samples obtained from the borings were subjected to limited laboratory testing to determine the pertinent engineering characteristics of the site soils. The laboratory testing included a grain size analysis of a selected soil sample using hydrometer. The results are included as Summary of Laboratory Test Data, Figure No. 6 and Grain Size Analysis, Figure No. 7 in the Appendix.

In addition to laboratory testing, field pocket penetrometer measurements were made as appropriate on representative cohesive soil samples obtained from the borings as an aid in evaluating their unconfined compressive strengths. The pocket penetrometer values are indicated on the boring logs.

5.0 GENERAL SUBSURFACE CONDITIONS

We have evaluated the soil and groundwater conditions encountered in the borings and have presented these conditions in the form of individual Logs of Soil Boring, Figure Nos. 4 and 5 in the Appendix. In addition to subsoil stratification, the boring logs present SPT results or N-values, observed groundwater levels, drilling and sampling information and other pertinent data. General notes defining the nomenclature used on the logs and within the text of this report are presented on Figure No. 3. We have prepared the boring logs on the basis of visual classification and limited laboratory testing.

The stratification indicated on the boring logs represents the subsurface conditions at the actual explored locations. Variations in subsurface conditions may occur between these locations. In addition, the stratigraphic lines represent the approximate boundary between material types. The transition from one material type to another may be more gradual than indicated.

Subsoil Conditions and Evaluations

The results of this investigation indicate that the proposed dewatering building site is generally underlain by existing fill materials overlying native cohesive and granular soils. The ground surface at the boring locations was covered with about 6 to 12 inches thick topsoil, consisting of dark brown clayey sand with organic matter. Directly underlying the topsoil cover, existing fill materials were encountered to an approximate depth of 12 feet below ground surface within the borings. The fills consist of granular or cohesive materials including brown sand with trace amounts of clay and gravel and dark brown sandy clay with trace amounts of gravel. N-values for the granular fills ranged from 9 to 36 blows per foot (bpf), indicating loose to dense conditions.

Underlying the existing fill materials, the borings encountered native cohesive and granular soil deposits. The native cohesive soils consist of gray silty clay with trace amounts of sand, gravel and occasional silty sand layers to a depth of about 32 feet. Pocket Penetrometer (PP) unconfined compressive strength measurements for the native silty clays ranged from 4,500 to in excess of 9,000 pounds per square foot (psf). The PP measurements for the native cohesive deposits indicate the presence of very stiff to hard consistency soils. The cohesive soils are, in turn, underlain by native granular soils to the explored depth of the borings (about 39 feet). The granular soils consist of gray silty sand with little clay and gravel. N-values for these native granular soils ranged from 50 blows for 5 inches to 100 blows for 5 inches, indicating very dense conditions. Results of the grain size analysis for the granular soil sample SS-10 obtained from about 39 feet depth within boring location B-1 revealed 12 percent gravel, 52 percent sand, about 23 percent silt and 13 percent clay content.

As mentioned above, existing fill materials were encountered in the soil borings to an approximate depth of 12 feet and these materials vary in strength and composition. We have not reviewed any documentation confirming that the existing fills were placed in an engineered manner. Due to the variability and unreliability of the existing fills, these materials are prone to settlement and are not

considered suitable for support of building foundations loads, and will require removal prior to new structural fill placement or installation of building foundations. However, following suitable site conditioning in accordance with procedures outlined in the Site Preparation section of this report, and provided some settlement can be tolerated and existing fills do not contain appreciable amounts of non-soil debris or other undesirable materials, we expect the fill materials can largely remain in place beneath floor slabs.

The native very stiff to hard silty clay soils or very dense silty sand soils underlying the existing fill materials are considered suitable for the direct support of the foundation loads of the type anticipated for this project.

Groundwater Conditions

Groundwater level observations were made at each boring location during and at the completion of drilling (end of drilling) operations. Groundwater was observed at depths of about 28½ feet (Elevation 688½ feet) and 29½ feet (Elevation 687 feet) during drilling within borings B-1 and B-2, respectively. Upon completion of drilling, groundwater was observed within these borings at approximate depths of 7 feet (Elevation 710 feet) and 6 feet (Elevation 710½ feet). In addition, caving was observed within the boreholes at approximate depths of 28 feet (Elevation 689 feet) in B-1 and at 26 feet (Elevation 690½ feet) in B-2.

Fluctuations in the groundwater levels at the site should be anticipated with seasonal variations and following periods of prolonged precipitation. In cohesive or other fine-grained soils encountered at the site, groundwater observations are not necessarily indicative of the hydrostatic or long-term water levels due to the low permeability of such soils and their tendency to seal off natural pathways of groundwater flow during drilling operations. The actual hydrostatic water levels or the presence of perched groundwater should be anticipated to fluctuate depending on variations in precipitation, surface runoff, infiltration, surrounding topography, drainage and nearby Flint River channel. Long-term groundwater levels including fluctuations in groundwater levels can best be determined through observations made in cased boreholes or observation wells over a prolonged period of time. The installation of cased boreholes was beyond the scope of the current investigation.

6.0 SITE PREPARATION

Based on the nature and type of anticipated construction, we have assumed that the finished grades will be close to existing ground surface. If shallow foundations are used, site preparation will require a significant amount of over excavation and backfilling due to the presence of existing fill materials, in order to bring the grades to desired elevations for construction purposes. Regardless of the amount of earthwork required to achieve final grades, it is recommended that all site and subgrade preparation activities be performed under adequate specifications and be properly observed in the field.

All areas intended to support new building foundations or grade raise fill must be properly prepared before proceeding with new construction. At the start of earthwork operations, existing grass cover,

topsoil and/or other unsuitable materials including organic matter, refuse and deleterious non-soil debris, as well as any other exposed soil containing obvious amounts of organic matter should be stripped in their entirety from within the proposed construction areas. The stripping should typically extend a horizontal distance of at least 5 feet beyond planned construction lines. All underlying existing fill materials or other unsuitable materials such as yielding soils should be removed in their entirety, where they exist below the proposed footing locations. All debris and materials resulting from the stripping operations and removal of existing fill from footing areas should be disposed of outside the proposed construction limits.

It is noted that a concrete obstruction, presumably construction debris, was encountered at an approximate depth of 5½ feet during drilling of boring B-2 at its initial location (initial B-2 location approximately 10 feet southwest of its final as-drilled location). Therefore, it is recommended that probes or test pits be performed prior to actual construction to evaluate the existence and lateral extent of the buried obstruction within the site soils. This will help the prospective bidders to reduce the potential of claims and construction delays.

All active and in-active utilities within or adjacent to the construction area should be identified for protection, relocation or abandonment prior to grading. Utilities that are to be left in place should be evaluated for their effect on the proposed project and vice versa. Existing backfill around utilities that are to remain should be checked for compaction and suitability to meet the project requirements and should be improved, if necessary. Excavations or voids resulting from site stripping, clearing and removal of existing fill materials and/or buried obstructions should be backfilled to surrounding grade or design subgrade level with approved and compacted granular engineered fill.

As mentioned earlier, within the shallow footings excavations, we recommend that all of the existing fill materials or any other yielding or unstable soils be removed in their entirety, where they exist at the proposed footing locations, and replaced with well-compacted granular engineered fill. Based on the soil boring data, it is anticipated that removal of existing fills from footing locations for the new building will extend to a depth of about 12 feet below ground surface. The exact depth and lateral extent of the fill materials within the building area should be expected to vary. Evaluation of the required depth of removal must be performed by a qualified person at the time of construction.

After rough grade has been established in cut areas and prior to placement of new grade raise fill in all fill areas, the exposed subgrade should be carefully observed by probing and testing as needed. All organic material (if any) still in place, frozen, wet, soft or loose soils and other unsuitable materials should be removed. The subgrade resulting from the removal of surficial materials is expected to consist primarily of existing granular and cohesive fills or native cohesive soils. Therefore, areas of exposed granular subgrade soils including those underlying the proposed building floor slab area should be thoroughly proof-compacted using a medium weight, smooth drum vibratory roller making a sufficient number of passes in each of two perpendicular directions. This is intended to densify any

loose granular soils or granular soils that have been disturbed by site clearing and grading operations, thereby improving their load supporting capability. If the operation of the vibratory roller is observed to decrease the stability of the subgrade soils by drawing water towards the subgrade surface, vibration should be discontinued and the roller should be operated in the static mode. The smooth drum roller should be kept a minimum distance of 10 feet from any existing structures and only light-weight compaction equipment such as a plate compactor or hoe-pak should be used to achieve the required compaction in these areas. The use of light weight compaction equipment will be more practical than use of a vibratory roller in areas adjacent to the existing facilities or in areas with limited space available for the heavier equipment to perform proof-compaction operations.

Areas that exhibit excessive movement or pumping during proof-compaction operations should be re-compacted or undercut and replaced with engineered granular fill or improved by using other methods depending upon site conditions at the time of construction. If undercutting is used, the undercut should be a minimum depth of 12 inches and the resulting excavation properly backfilled with engineered MDOT Class II or 21AA materials.

In addition to proof-compaction operations, areas where the exposed subgrade consists of cohesive soils, the subgrade should be thoroughly proof-rolled using heavy rubber tired roller or earthmoving equipment such as a loaded dump truck or loaded scarper. Any areas of cohesive subgrade soils that exhibit excessive movement or instability during proof-rolling operation should be stabilized by aeration, drying and re-compaction, if weather conditions are favorable, or by removal of the yielding soils and their replacement with engineered granular fill.

As mentioned above, within the footprint of the proposed building, a concrete obstruction was encountered at a depth of about 5½ feet below ground surface. Where old construction debris (i.e., concrete, rubble, abandoned utility lines, etc.) is encountered during excavations, it must be removed in its entirety or at least where it is encountered below the new footings and replaced with compacted granular engineered fill. If old construction debris is encountered within the proposed on-grade slab area, it should be removed to a depth of at least 18 inches below the final subgrade elevation; any slabs or pads encountered below this depth should be thoroughly broken up prior to the placement of new engineered fill to allow for passage of water.

Material for backfill or engineered fill required to achieve design grades should preferably consist of free-draining and well-graded non-organic granular soils, such as soils meeting the requirements of Michigan Department of Transportation (MDOT) Class II or equivalent granular material. The on-site granular soils that are free of organic matter and other deleterious materials may be used for engineered fill materials provided they are approved by a qualified representative of the project owner and placed under favorable weather conditions to control moisture.

Engineered fill should be placed in uniform horizontal lifts, the thickness of which is compatible with the type and condition of material being placed, area of placement and type of compaction equipment being used. In general, we recommend that lifts be placed in 12 inches (or less) in loose thickness for materials being compacted with a medium smooth non-vibratory roller for granular soils. Other types of compaction equipment may require reducing lift thickness in order to achieve suitable compaction. Within structural areas, the fill should be compacted to achieve a density of at least 95 percent of Maximum Dry Density (MDD) as determined by the Modified Proctor compaction test (ASTM D 1557). All fill material should be placed and compacted at or near optimum moisture content. In-situ density tests should be performed to verify that proper compaction is achieved. Frozen material should not be used as fill, nor should fill be placed on a frozen subgrade.

Extreme care must be exercised when making excavations close to any existing facilities include below grade utilities, vaults, tunnels, conduits, drains, influent or other piping and/or other nearby facilities to prevent undermining or damage to the supported facilities. Open excavations for new footings or pipe trenches should not extend below the bearing level of any adjacent footings or pipe inverts. If excavations must be extended deeper than any existing footings or pipe/tunnel inverts, provisions should be made either to underpin the existing footings and inverts or to provide lateral support system to prevent movement of existing structures during the time the nearby excavations are open. For conventional footings, the support measures may include temporary support systems or underpinning of any existing footings or inverts adjacent to open excavations. Furthermore, if the new footings are located within the zone of influence of the existing footings or other below grade structural elements such as pipe/tunnel inverts and floor slabs, it will also be necessary to account for the loading of the existing footings or these other below grade structures on the support systems as well as the new foundations. The zone of influence of a footing may be considered to extend from the edge of the footing bottom in a downward direction away from the footing at a slope of 1 unit horizontal to 1 unit vertical (1H: 1V).

The subgrade resulting from the satisfactory completion of site and subgrade preparation operations can be used for supporting on-grade concrete floor slabs. However, if the existing fill materials are allowed to remain below the floor slab, some settlement of the floor slab cannot be precluded. To virtually eliminate settlement of the floor slabs, the existing fill materials would need to be removed in their entirety and be replaced with engineered fill. In addition, we recommend that all floor slabs be suitably reinforced and separated from the building foundation system to allow for independent movement. All ground-supported floor slabs placed beneath or around the building should be underlain by a base course layer consisting of a minimum of 6 inches of crushed limestone aggregate material such as MDOT 6AA compacted to at least 95 percent of the Maximum Dry Density (MDD) as determined by the ASTM D 1557 Modified Proctor test. Prior to the placement of base course layer and concrete, the upper 12 inches of surficial subgrade soils anticipated below the slabs should be scarified, moisture-conditioned and re-compacted to at least 95 percent of MDD as determined by

ASTM D 1557. The final site grades should be oriented to drain storm water and/or other surface runoff away from the floor slabs and any nearby existing structures.

7.0 FOUNDATION RECOMMENDATIONS AND SITE CLASS

The following recommendations have been developed on the basis of the previously described project characteristics and our evaluation of the subsurface conditions encountered during the current investigation. If there is a change in the project characteristics, including anticipated structure loads and building location at the site, a review should be made by our office.

Shallow Foundations

Soil conditions encountered within the borings completed at the location of the proposed dewatering building consist of about 12 feet deep existing fill materials over very stiff to hard native cohesive soil deposits which, in turn, are underlain by very dense granular soils. The existing fill materials are prone to settlement upon application of additional loads and, therefore, are not considered suitable for support of conventional shallow foundations. We recommend that building foundations not be supported on this existing fill. It is recommended the existing fill materials be undercut in their entirety where they are encountered at the building footing locations and replaced with structural or engineered fill consisting of new compacted granular materials placed over suitable native soils. The intent of undercutting is to minimize the risk of settlements and to provide a uniform bearing surface for foundation support via a uniform thickness of compacted fill beneath load bearing elements. Engineered fill placement should be performed in strict accordance with the Site Preparation recommendations discussed above in Section 6.0 of this report.

Following undercutting and replacement with compacted engineered fill, the proposed building may be supported on conventional shallow foundations bearing in the new compacted engineered fill materials. A net allowable soil bearing pressure of 2,500 pounds per square foot (psf) may be used for the design of shallow building footings that bear upon approved compacted engineered fill placed over suitable native soils. Lean concrete (2,000 pounds per square inch mix or better) may be used as an alternative to compacted granular fill if approved by the structural engineer. The allowable bearing pressure may be increased by 33 percent for short term loading due to wind or seismic forces. Due to the presence of existing undocumented fills at the site, shallow foundations will require substantial amounts of undercutting and additional measures to protect any nearby above or below-grade existing facilities or structures. Further, it is noted that the depth of existing fill materials may vary significantly between or away from the borings completed for the current investigation.

All strip footings should be at least 18 inches in width and all isolated spread footings should be at least 30 inches in their least dimension regardless of the resultant bearing pressure. The footings should be established at a depth of at least 3½ feet below exposed finished grade for protection against frost penetration. The determination of the required depth of excavation at each footing location should be performed by a qualified representative of the project owner. We recommend that all

foundation excavations should be checked and tested in the field to verify that adequate in-situ soil bearing pressures, compatible with the recommendations outlined in this report, are achieved. Should loose soils be present at the base of footing excavations, these soils should be densified in place using a plate compactor or hoe-pak in order to compact the soils and improve their bearing capability, or the loose soils must be removed until suitable bearing soils are achieved or should be replaced with engineered fill.

It is imperative that the sidewalls of the building footing be maintained vertical during the concrete pour. If footings for the new structure are constructed by directly placing concrete in unformed excavations (trench footings), the footing may become wider at the top as sloughing of upper surrounding granular fill occurs and will develop a “lip” or flare outward. Such condition may cause the footing to heave despite the bottom of the footing being below the frost depth, due to the frozen soils lifting the upper (wider) portions of the footing. As such, if the footing excavations cannot be maintained with vertical sides, we recommend the use of formwork to construct the footing under these conditions.

Soils exposed in the bases of all satisfactory foundation excavations should be protected against detrimental change in condition such as from disturbance, precipitation and freezing. Surface runoff water should be drained away from the excavations and not allowed to pond. Foundation excavations should be concreted as soon as practical after they are excavated. If possible, all footing concrete should be poured the same day the excavation is made. If an excavation is left open for an extended period, a thin mat of lean concrete should be placed over the bottom to minimize damage to the bearing surface from weather or construction activities. Foundation concrete should not be placed on frozen or saturated subgrades.

As discussed earlier, extreme care must be exercised when making excavations close to existing facilities including product piping, drains, conduits, tunnels, vaults, utilities, on-grade equipment or other nearby surface/below-grade structures to prevent undermining or damage to the supported facilities. Open excavations for new footings should not extend below the bearing level of any adjacent footings or pipe/tunnel inverts. If excavations must be extended deeper than any existing footings or inverts, provisions should be made either to underpin these below-grade structural elements or to provide lateral support system to prevent movement of existing structures during the time the nearby excavations are open. For conventional footings, the support measures may include temporary support systems or underpinning of any existing footings, floor slabs or pipe/tunnel inverts adjacent to open excavations. Furthermore, if the new building foundations are located within the zone of influence of any existing footings or other below-grade structural elements, it will also be necessary to account for the loading of existing structural elements on the support systems as well as the new foundations. The zone of influence of a footing may be considered to extend from the edge of the footing bottom in a downward direction away from the footing at a slope of 1H: 1V.

Nearby foundation elements bearing at different levels should be designed and constructed so that the least lateral distance between them is equivalent to or greater than the difference in their bearing levels. To achieve a change in the level of a strip footing, we recommend the footing be gradually stepped at a grade no steeper than two units horizontal to one unit vertical (2H: 1V).

Resistance to lateral loads may be provided by frictional resistance between the bottom of concrete footings and the underlying soils and by passive soil pressure against the sides of the footings. The coefficient of friction between poured-in-place concrete footings and underlying soils may be taken as 0.30. Passive pressure available in compacted fill or undisturbed native soils may be taken as equivalent to the pressure exerted by a fluid weighing 200 pounds per cubic foot (pcf). The above recommended values include a factor of safety of 1.5; therefore, frictional and passive resistance may be used in combination without reduction.

Total settlements of spread and strip footings will vary, depending on the size of the footing and the actual load supported. Footing settlements have been estimated based on anticipated loading conditions. If the recommendations outlined in this report are followed, total and differential settlements of the new building supported on shallow foundations are anticipated to be within approximately 1 inch and ½ inch, respectively. As a precaution, structural and utility connections to new construction supported on shallow foundations should be deferred until a majority of the dead load resulting from construction has been applied. Careful field control during construction will substantially reduce the actual settlements that occur. It is imperative that all fill and backfill materials placed beneath, above and against the sides of the foundations be thoroughly compacted at appropriate moisture content and density as described in the Site Preparation section of this report. We recommend that all footings be suitably reinforced to reduce the effects of normal differential settlements associated with local variations in subsoil conditions.

Alternate Drilled Pier Foundations

If the use of conventional shallow foundations is considered to be impractical due to the presence of significant depth of existing fill materials, limited site space or close proximity to nearby structures, below-grade utilities, tunnels and other adjacent structural elements, the proposed building may be supported using an alternate foundation option consisting of a system of shallow straight shaft drilled piers bearing in suitable native soils consisting of very stiff to hard silty clays underlying the existing fill materials at the site. Based on the subsoil conditions encountered at the boring locations, suitable native bearing soils for drilled pier foundations designed to derive support from end bearing are anticipated at a minimum depth of about 15 feet below existing surface. We recommend the pier foundations at the proposed building location be extended through the upper fill soils to bear into the lower suitable native clay soils. Drilled piers supported by very stiff to hard native clay soils anticipated at or near Elevations 701½ to 702 feet may be designed based on a net allowable bearing pressure of 3,000 psf provided the piers are established to a minimum embedment depth of 15 feet and with a diameter of 36 inches or less. The excavations for drilled piers should not be extended deeper

than necessary during construction to avoid disturbing the native clay soils or not leaving a sufficient thickness of suitable clay soils between the bearing level of pier foundations and the lower clay soils.

In all cases, the drilled piers must bear at a depth of at least 3½ feet below the surrounding ground surface for protection against frost penetration. The weight of the buried portion of the pier may be ignored when calculating downward axial loads on the pier. A one-third increase in the allowable capacity may be used for consideration of transient loads such as wind or seismic. If deemed necessary by the structural engineer, consideration may be given to use of grade beams to span between the piers and to provide additional lateral resistance and maintain foundation alignment and integrity. If utilized, the grade beams should be founded at a depth of at least 3½ feet for protection against frost heave.

For resisting lateral loads, drilled piers may be designed by using a passive soil resistance of 200 psf/ft of pier embedment depth up to a maximum of 1,800 psf. The allowable lateral pressures recommended herein are based on anticipated subsoil conditions and that the drilled piers will be located no closer together than three pier diameters on-center. If pier foundations are installed at a spacing of less than 3 pier diameters, it will be necessary to revise and reduce the lateral pressure recommendations above. Regardless of the materials encountered, no passive soil resistance should be considered to a depth equal to one pier diameter. The above pressures should be considered to act only on the projected area of the foundation. The magnitude of lateral movement of drilled piers subjected to overturning loads is dependent upon and is a non-linear function of the magnitude of the applied lateral load and load eccentricity with respect to the ground surface. The drilled pier foundations should be designed to maintain both force and moment equilibrium.

Depending on their depth and location, the excavations for drilled piers are anticipated to extend through the upper existing fill materials and terminate in underlying native clay soils. Excavation bottom soil conditions may consist of variable consistency and/or relative density soils depending upon the final excavation depth. The pier foundation excavations should be evaluated at the time of construction for bottom stability based on actual site soil conditions. All pier foundation excavations should be checked and tested to verify that adequate in-situ soil bearing pressures, compatible with the design value, are achieved. The determination of the required depth of excavation at each pier foundation location should be performed by a qualified person. If sufficient bearing pressure is not available at the design bearing level, the pier size will need to be increased in the field until suitable bearing soils are encountered in order to adequately accommodate the structural loads. Because the piers are anticipated to be end bearing, all loose material should be removed from the pier excavation, prior to placement of reinforcing steel and concrete.

Groundwater was observed during drilling at approximate depths of 28½ feet and 29½ feet below ground surface (about Elevations 688½ feet and 687 feet) at boring locations B-1 and B-2. Upon completion, groundwater levels rose to as much as 6 to 7 feet depth (about Elevation 710 feet) below

ground surface within the borings. In addition, borings encountered existing sandy fills extending to a depth of about 12 feet below surface, which could provide a natural flow path for groundwater to enter drilled pier excavations. If drilled pier foundations are used on the project, the pier excavations are expected to extend to a depth of at least about 15 feet. Therefore, possibility exists that groundwater may be encountered during pier excavations for the project. It will be necessary to control groundwater inflows into pier excavations. Fluctuations in the groundwater levels and/or trapped water within the granular soils should be anticipated especially after a precipitation event and with seasonal variations following periods of prolonged precipitation. Therefore, the actual water levels at the site may vary at the time of construction.

Caving was observed in the soil borings at approximate depths of 26 to 28 feet (Elevations 690½ to 689 feet). Therefore, to prevent the sides of the pier excavations from collapsing and to control groundwater seepage from the granular soils, a temporary steel casing will be required in the construction of the drilled piers. The casing should be extended into the suitable native clay stratum in order to seal the casing to prevent soil or water intrusion into the pier shaft excavation, prior to placing reinforcing steel and concrete. The casing may be full or partial depth depending upon the subsurface conditions encountered at the time of construction. We recommend that the design plans indicate that casing (or sufficient side support) be required for all pier excavations for the installation of pier foundations. The casing could be drilled (i.e., twisted) into position prior to shaft excavations, such that the surrounding soils providing drilled pier lateral resistance to structure loads do not experience significant disturbance. At locations, where drilled piers will be installed in close proximity to any nearby structures, below-grade utilities or other facilities, it is recommended that the piers be installed by twisting the casing into the ground instead of driving or vibrating as the excavation proceeds. Additional discussion regarding pier installation construction methods is provided below.

The selection of the location of final pier foundation elements for the new building will be influenced by factors including prevailing subsurface conditions at the pier locations, presence of utilities and proximity to other above or below-grade facilities. Based on our site observations and the MISS DIG markings noted in the field at the time of our field explorations, as well as the presence of existing facilities anticipated within or near the proposed construction area, extreme care must be exercised by the contractor when performing excavations near these existing facilities that are to remain in order to protect them from potential damage. The contractor should be fully aware of the locations of all existing above or below-grade facilities such as utilities, piping and tunnels before excavating for the pier foundations and be prepared to support or brace the excavations as required so that these existing facilities are not impacted by the construction and they also do not impede the construction operations. As an added precaution, we recommend that the contractor be required to review readily available historical utility maps and as-built drawings for all nearby structures at the local city or county offices in addition to any utility plans and as-built drawings made available by the project owner prior to

approval of the final layout of the pier foundation locations. Furthermore, detailed construction procedures should be submitted by the contractor for review and approval by the engineer.

It is anticipated that if drilled pier foundations are used, the project will involve construction-related activities including installation of temporary casing, pier shaft excavations and compaction of soils around the pier foundations. To prevent risk of damage to any nearby facilities, utilities and other improvements from excessive caving or potential ground loss, or vibrations associated with these construction activities, the contractor should take all precautions in selecting appropriate construction means and methods. Furthermore, the contractor should exercise utmost care in selecting the type of method used for installing the temporary casing in order to prevent settlement of or damage to adjacent facilities. Use of vibratory hammers to install casing is not recommended and should not be allowed on the project. This is to prevent potential densification of the granular soils and associated settlements of any nearby utility lines and/or other adjacent facilities that could result from construction methods involving use of vibratory hammers or other types of equipment producing significant vibrations. A qualified representative of the project owner should be onsite during drilled pier excavation and installation operations to continuously observe and verify suitable bearing materials are encountered, bearing surface has been properly cleaned, piers are plumb and appropriate construction methods are employed for installation of drilled piers.

After the pier excavation is complete, the hole has been cleaned and reinforcement set, concrete should be placed using a concrete pump or by tremie method. It is important that the concrete be placed and casing removed in such a manner as to prevent necking of the drilled pier. Segregation of aggregate during concrete placement should be minimized. When withdrawing the casing during concreting operations, special care should be taken to prevent water and/or soil intrusion into the pier excavation. To prevent such intrusion, a sufficient level of concrete should be maintained above the tip of the casing as it is being withdrawn so as to offset any hydrostatic pressure head that may exist in granular soils above the bearing level.

The drilled pier foundations should be installed by an experienced and competent contractor who will also be responsible for properly installing the piers in accordance with applicable industry standards and generally accepted methods without causing deterioration of subgrade conditions or impacting any existing adjacent structures that are to remain. With regard to the drilled pier construction, the duration of construction must be accounted for. We recommend that construction methods make certain that the pier excavation is not left open overnight prior to placing of concrete. To reduce the lateral movement of the pier shaft, all voids or enlargements in the drilled pier shaft due to over-excavation (if any) or caving soil conditions must be filled with concrete at the time the drilled pier concrete is placed. Initial set of concrete should be achieved before an adjacent pier is drilled.

Provided the site and subgrade preparation and foundation recommendations in this report are followed, the total and differential settlements for individual pier foundations are estimated to be less than 1 inch and ½ inch, respectively. We recommend that all drilled piers be suitably reinforced to withstand the effects of vertical compression and lateral overturning loads. The structural design of drilled piers and/or grade beams including reinforcement details should be performed by the project structural engineer.

Seismic Site Class

In general, seismic activity and earthquake potential throughout the State of Michigan is considered to be somewhat low. General industry guidelines were followed in estimating the seismic site classification for the project. The site classification is typically based on the relative stiffness for soil and rock layers within a 100-foot soil/rock column. However, none of the borings completed for this investigation were taken to a 100-foot completion depth. Therefore, the idealized soil/rock column used for estimating seismic site classification is based on our review of the regional geologic conditions and past project experience in the general site vicinity. Based on the review of subsurface conditions encountered in the borings completed for this investigation, as well as our knowledge of regional geologic setting and general subsurface conditions from past project experience in the site vicinity, the subject site may be classified as Site Class D in accordance with the definitions given in Section 1613.5.2 of the 2009 Michigan Building Code, which is based on the 2012 International Building Code®.

8.0 SUPPORT OF FLOOR SLABS

The subgrade resulting from the satisfactory completion of site preparation activities recommended in Section 6.0 above can be used for the support of concrete floor slabs-on-grade anticipated for the proposed building. However, due to existing underlying fill materials and other variations within subsoils at the proposed building location, the possibility of some floor slab settlement cannot be precluded. Accordingly, we recommend that all ground-supported concrete floor slabs be suitably reinforced and separated from the foundation system to allow for independent movement. Further, in order to protect the subgrade soils from construction-related disturbances, reduce differential settlements of the existing fill materials and equalize moisture conditions beneath the slab as well as provide a stable working platform, it is recommended that the floor slab be supported on a minimum 6-inch well-compacted layer of free draining granular base course material such as MDOT 6AA (coarse aggregate). If no floor slab settlement can be tolerated, alternate measures such as complete removal of existing fill materials or structural support of floor slabs using grade beams will be necessary. Provided that the site conditioning recommendations outlined in the Site Preparation section of this report are followed and a minimum of 6-inch granular base is placed beneath the floor slabs, a modulus of subgrade reaction value of 100 pounds per cubic inch (pci) may be used for the design of floor slabs supported on existing fill at the site. This estimated value corresponds to a 1 foot by 1 foot plate load test.

Based on our past experience from other projects involving construction of on-grade concrete slabs, there is sometimes substantial time lag between initial grading and the time when the contractor is ready to construct the slab-on-grade. Even though the subgrade soils may have been prepared and compacted adequately during initial grading, exposure to weather and construction traffic can impact the integrity of subgrade soils. Therefore, prior to the construction of on-grade concrete slabs for the new building, the floor slab subgrade should be closely evaluated by a qualified representative of the testing agency. We suggest that provisions be included in the project specifications for the contractor to restore the subgrade soils to an acceptable condition prior to construction of slabs. Such restoration may include moisture conditioning of the surficial soils and re-compaction to the project requirements.

If the floor slab is to be covered with moisture sensitive flooring or coatings, consideration should be given to the use of a 4-inch thick layer of sand underlain by a no less than 10-mil thick plastic sheet vapor barrier beneath the floor slab. The placement of vapor retarder/barrier should be in accordance with the project specific needs, current version of the American Concrete Institute (ACI) 302.1 guidelines, local building codes and the recommendations of the flooring manufacturer. Special care should be exercised during construction activities to prevent damage to the vapor retarder.

9.0 TEMPORARY EXCAVATIONS

Excavations for the project should comply with the current Michigan Department of Labor and Regulatory Affairs (LARA) requirements, *i.e.*, the Michigan Occupational Safety and Health Act (known as MIOSHA) and related Federal OSHA regulations, as well as any additional local regulations or owner requirements must be strictly followed and adequate protection provided for workers and adjacent structures. We are providing the information below solely as a service to our client. Under no circumstances should the information provided herein be inferred to mean that GeoTran is assuming responsibility for temporary excavations, construction site safety, activities of the contractor, or for design, installation, maintenance and performance of any shoring, bracing, underpinning, or other similar systems. Such responsibility is not implied and should not be inferred.

All cuts deeper than 5 feet should be properly sloped or otherwise structurally retained to provide stable and safe working conditions. Construction site safety generally is the sole responsibility of the contractor. The contractor is also solely responsible for designing and constructing stable, temporary excavations and must shore, slope, or bench the sides of the excavations as required to maintain stability of both excavation sides and bottom. The contractor should be aware that slope height, slope inclination, and excavation depths should in no case exceed those specified in the local, state, or federal safety regulations including OSHA Health and Safety Standards for Excavations, 29CFR Part 1926, or successor regulations. Excavations must be performed and evaluated under the supervision of the contractor's designated competent person. The competent person must verify the soil conditions based on actual materials encountered during excavation activities and field conditions at the time of excavation in order to determine the permissible temporary slope inclinations. In areas, where there is insufficient space to allow for proper side slopes for excavations due to adjacent

structures, utilities or other surface or below-grade facilities, vertical walls with properly designed and installed lateral bracing, or a combination of slopes and braced vertical walls may be used. The contractor should thoroughly review the site conditions and available as-built drawings for all existing facilities located within or directly adjacent to the construction area, be aware of existing utility locations, tunnels, piping, vaults, and adjacent buildings before initiating excavation activities; and be prepared to support or brace the existing facilities, as appropriate.

With time and the presence of seepage and/or wet weather, the stability of temporary cuts can be significantly reduced. Therefore, construction should proceed as quickly as possible to limit the time the excavations are left open. In addition, runoff water should be prevented from entering the excavations, by collecting and disposing of outside the construction limits. To prevent runoff from adjacent areas from entering the excavation, a perimeter berm may be constructed at the top of the excavation or slope. Additionally, temporary cut slopes, where utilized, should be covered with plastic or Visqueen sheeting to help minimize erosion during wet weather and closely observed in the field until the foundation installation and backfilling activities are complete.

Construction traffic and excavated material stockpiles should be kept away from excavations a minimum distance equal to the full depth of the excavation, unless the resulting surcharge loads are accounted for in the design of the lateral bracing system. In addition, the effect of the existing building foundations, buried piping, tunnels or any other nearby structures must also be considered in the design of the bracing system. The contractor's proposed excavation plan, support systems and sequence of construction should be reviewed by a qualified engineer prior to allowing the contractor to commence work.

A pre-construction survey for the project should be considered owing to the close proximity of the site or construction area to existing nearby facilities. The survey should record the elevation and horizontal position of all existing installations directly bordering the construction area and may consist of photographs, videotaping, etc. Vibration monitoring may be considered if heavy construction equipment capable of producing substantial vibrations is utilized on the project. Furthermore, if shallow conventional footings that will require significant amounts of undercutting and replacement with engineered fill are selected for the new building, a settlement survey should be performed on a weekly basis during excavation and on a monthly basis, approximately one month after the excavations have been completed, at a minimum.

10.0 GROUNDWATER CONTROL

Groundwater was encountered within borings at approximate Elevations of 688½ to 687 feet during drilling and at about Elevation 710 feet upon completion of borings. Based on the water level data obtained in the borings and depending upon the location of groundwater or water-bearing granular strata and the amount of precipitation prior to and during construction, appreciable amounts of groundwater infiltration may be encountered within shallow footing construction excavations for the

project. Groundwater levels are subject to seasonal, climatic and other variations and may be different at other times and locations than those stated in this report. We anticipate that accumulations of surface water runoff or groundwater seepage in foundation excavations can be controlled by conventional dewatering methods such as standard pumping from small dug sumps formed at the base of the excavations and located outside of the zone of influence of footings, and provided that inflows from any overlying saturated granular seams and layers are controlled. In addition, a layer of crushed concrete, coarse aggregate or mud mat may be required to stabilize wet soils at the bottom of excavations.

Excavations that terminate more than one to two feet below groundwater level are expected to encounter moderate to heavy volumes of groundwater. In addition, a “quick” condition may develop as groundwater migrates towards excavations, resulting in the disturbance of soils, and a reduction in their supporting capabilities. Based on these considerations and because standard sump and pump methods may not be adequate, positive or special groundwater control measures, such as dewatering wells or well points will be required before making excavations below the groundwater level. It should be noted that granular soils that contain more than about 15 percent silt and clay will be difficult to effectively dewater and may require closely spaced dewatering systems. Dewatering systems, where used, should be properly designed to prevent soil fines from being pumped out of the subsurface soil layers. The discharge water from the dewatering system should be monitored to verify that this condition does not develop. In addition, consideration should be given in the design of the dewatering system such that the groundwater levels are not drawn down too deep so as to affect the existing structures. The contractor should be prepared to provide a dewatering system during construction that is capable of maintaining dry excavations.

In general, where groundwater is encountered within foundation excavations for drilled piers (if used), temporary casing is recommended to control groundwater seepage and to keep the existing granular fills from collapsing into the pier excavation. It is important that the contractor be prepared for installing drilled piers below the groundwater level in saturated granular soils. Dewatering of wet shafts should not be allowed and is not recommended. If the use of temporary casing is found to be ineffective in controlling groundwater inflows, it may be necessary to use bentonite slurry to stabilize the excavation sides and/or bottom. The use of slurry will require that concrete be placed within the pier by tremie method. Additional information regarding groundwater control measures in drilled pier excavations is discussed in Section 7.0 above.

11.0 DATA REVIEW AND FIELD VERIFICATION

We should be provided the opportunity to review geotechnical portions of the final plans and specifications. The purpose of the review will be to verify that the intent of our recommendations set forth in this report have been correctly interpreted and included in the design of the project.

We recommend that a qualified firm be retained to provide observation and testing services during the earthwork and foundation construction phases of the proposed project. This is to verify the anticipated subsurface conditions are present and observe compliance with the design concepts, specifications and recommendations. Also, field verification allows appropriate design or construction changes to be made in a timely manner if conditions differ from those anticipated prior to the start of construction.

12.0 LIMITATIONS

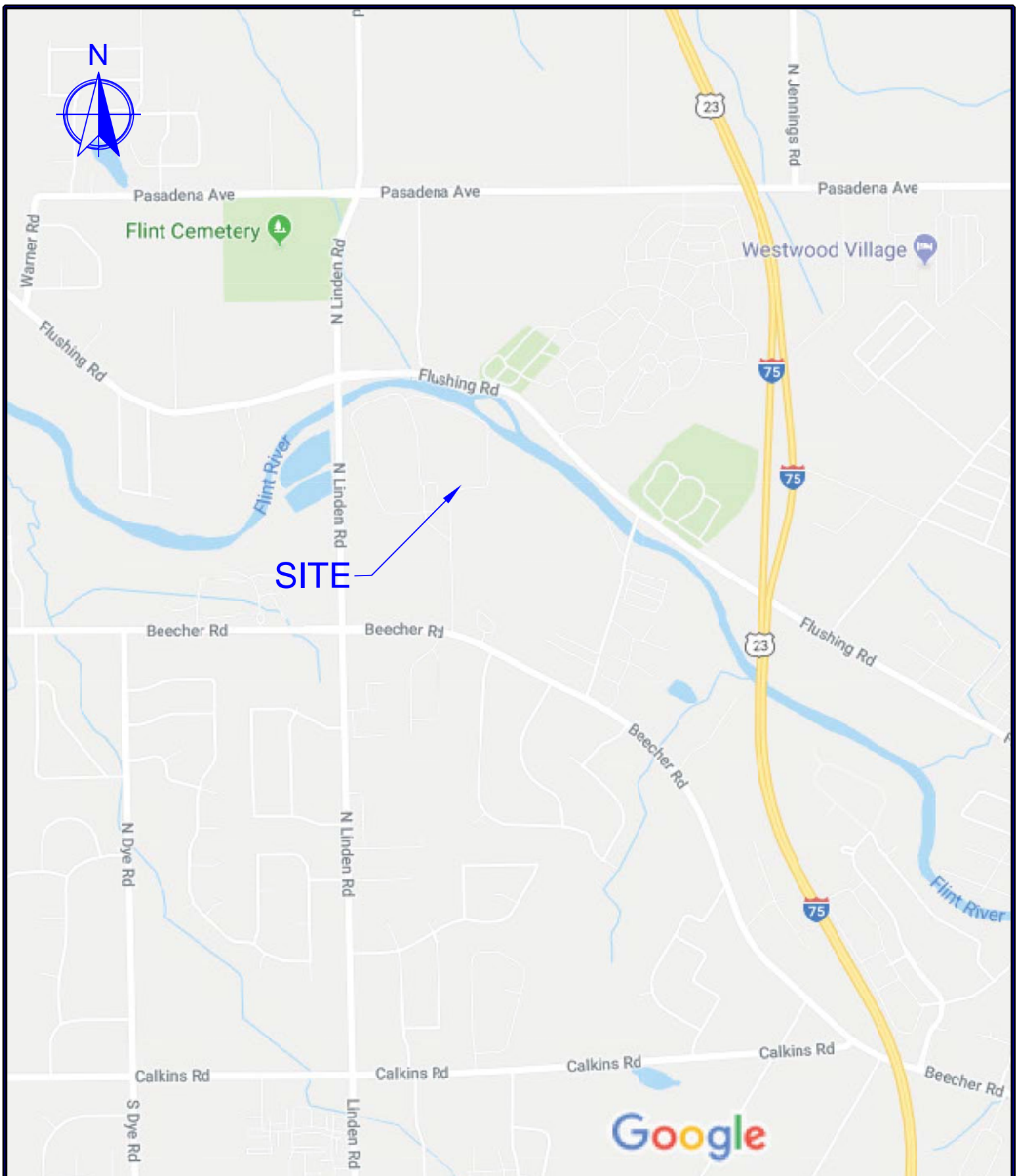
We have prepared this report exclusively for Wade Trim, Inc. for the project specifically described in this report. Our professional services have been performed, our findings obtained and our recommendations prepared in accordance with the generally accepted geotechnical engineering practice, as it exists in the project area at the time of our study. No other warranty or representation, expressed or implied, is included or intended in this report.

Our recommendations for this project were developed utilizing subsurface information from the soil borings performed at the site. At this time, we would like to note that borings only depict the subsurface conditions at the specific locations and time at which they were made. The subsurface conditions at other locations on the site may vary from those occurring at the boring locations that we have explored to date. If significant variations are exposed during construction, they should be brought to our attention as it may be necessary for us to reevaluate the recommendations of this report.

The conclusions and recommendations presented in this report have been developed based upon the data obtained from the borings and our current understanding of the proposed construction. Any revision in the plans for the proposed construction from those anticipated in this report should be brought to our attention to determine whether any changes in the foundation or site preparation recommendations are necessary. This report reflects our opinion as of this date, based on the results of the study described herein and on the information provided during the course of the study. The results of this study may not be relied upon by entities other than those identified above without the prior knowledge and written consent of GeoTran.

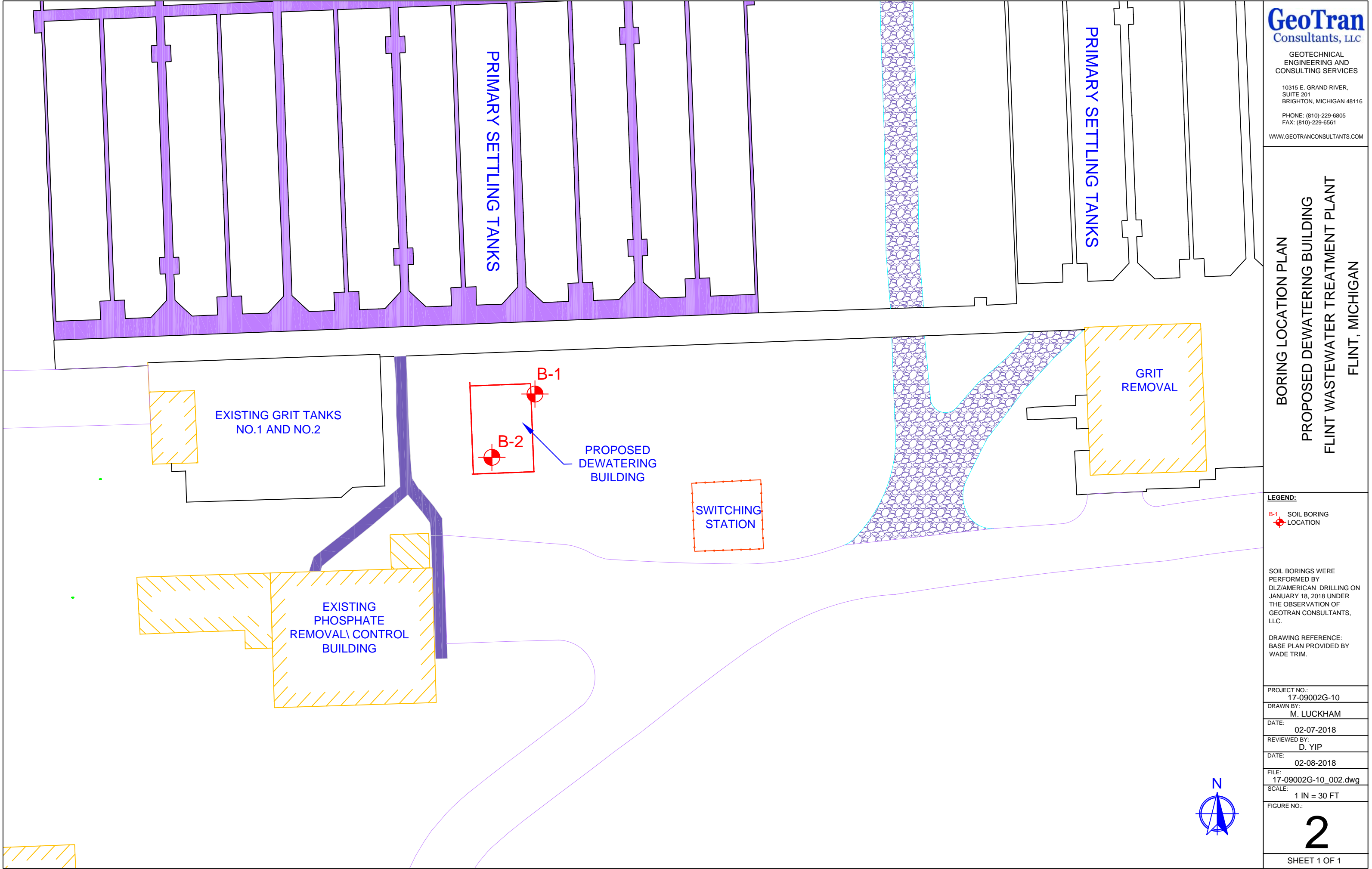
The scope of the current study was limited to geotechnical exploration of the subsurface conditions for the support of the proposed dewatering building and other related aspects of construction. No chemical, environmental, or hydrologic testing or analyses were performed as part of this study.

APPENDIX



SITE LOCATION MAP
PROPOSED DEWATERING BUILDING
FLINT WASTEWATER TREATMENT PLANT
FLINT, MICHIGAN

PROJECT NO.: 17-09002G-10	FILE NAME: 17-09002G-10_001.DWG	FIGURE NO.: 1
DRAWN BY: M. LUCKHAM	DATE: 1-22-2018	
REVIEWED BY: D. YIP	DATE: 1-22-2018	
SCALE: NOT TO SCALE	SHEET NO.: 1 OF 1	



BORING LOCATION PLAN

PROPOSED DEWATERING BUILDING

FLINT WASTEWATER TREATMENT PLANT

FLINT, MICHIGAN

LEGEND:

B-1 SOIL BORING
LOCATION

SOIL BORINGS WERE
PERFORMED BY
DLZ/AMERICAN DRILLING ON
JANUARY 18, 2018 UNDER
THE OBSERVATION OF
GEOTRAN CONSULTANTS,
LLC.

DRAWING REFERENCE:
BASE PLAN PROVIDED BY
WADE TRIM.

PROJECT NO.:	17-09002G-10
DRAWN BY:	M. LUCKHAM
DATE:	02-07-2018
REVIEWED BY:	D. YIP
DATE:	02-08-2018
FILE:	17-09002G-10_002.dwg
SCALE:	1 IN = 30 FT
FIGURE NO.:	

GENERAL NOTES

TERMINOLOGY

Unless otherwise noted, all terms utilized herein refer to the Standard Definitions presented in ASTM D 653.

SAMPLE DESIGNATIONS

AS - Auger Sample - directly from auger flight	RC - Rock Core - NX core unless otherwise noted
BS - Miscellaneous Sample - bottle or bag	CS - Continuous Sample - from rock core barrel or Continuous sampling device
SS - Split Spoon Sample - ASTM D 1586	VS - Vane Shear
LS - Split Spoon Sample S with Liner Insert 3 inches in length	HA - Hand Auger Sample
ST - Shelby Tube Sample - 3 inch diameter unless otherwise noted	PID - Photo Ionizataion Detector
PS - Piston Sample - 3 inch diameter unless otherwise noted	

PARTICLE SIZES

Boulders - Greater than 12 inches (305mm)
Cobbles - 3 inches (76.2mm) to 12 inches (305mm)
Gravel - Coarse - 3/4 inches (19.05 mm) to 3 inches (76.2mm)
Fine - No. 4 - 3/16 inches (4.75mm) to 3/4 inches (19.05 mm)
Sand - Coarse - No. 10 (2.00mm) to No. 4 (4.75mm)
Medium - No. 40 (0.425mm) to No. 10 (2.00mm)
Fine - No. 200 (0.074mm) to No. 40 (0.425mm)

CLASSIFICATION

The major soil constituent is the principal noun, i.e., clay, silt, sand, gravel. The second major soil constituent and other minor constituents are reported as follows:

Second Major Constituent (percent by weight)	Minor Constituent (percent by weight)
Trace - 1 to 12%	Trace - 1 to 12%
Adjective - 12 to 35% (clayey, silty, etc.)	Little - 12 to 23%
And - Over 35%	Some - 23 to 33%

COHESIVE SOILS

<u>Consistency</u>	<u>Unconfined Compressive Strength (psf)</u>	<u>Approximate Range of (N)</u>
Very Soft	Below 500	0 - 2
Soft	500 - 1000	3 - 4
Medium Stiff	1000 - 2000	5 - 8
Stiff	2000 - 4000	9 - 15
Very Stiff	4000 - 8000	16 - 30
Hard	8000 - 16000	31 - 50
Very Hard	Over 16000	Over 50

Consistency of cohesive soils is based upon an evaluation of the observed resistance to deformation under load and not upon the Standard Penetration Resistance (N).

If clay content is sufficient so that clay dominates soil properties, clay becomes the principal noun with the other major soil constituent as modified; i.e., silty clay. Other minor soil constituents may be included in accordance with the classification breakdown for cohesionless soils; i.e., silty clay, trace of sand, little gravel.

COHESIONLESS SOILS

<u>Density Classification</u>	<u>Relative Density %</u>	<u>Approximate Range of (N)</u>
Very Loose	0 - 15	0 - 4
Loose	16 - 35	5 - 10
Medium Dense	36 - 65	11 - 30
Dense	66 - 85	31 - 50
Very Dense	86 - 100	Over 50

Relative density of cohesionless soils is based upon the evaluation of the Standard Penetration Resistance (N), modified as required for depth effects, sampling effects, etc.

DEPOSITIONAL FEATURES

Parting - as much as 1/16 inch thick	Varved - alternating seams or layers of silt and/or clay and sometimes fine sand
Seam - 1/16 inch to 1/2 inch thick	Occasional - one or less per foot of thickness
Layer - 1/2 inch to 12 inches thick	Frequent - more than one per foot of thickness
Stratum - greater than 12 inches thick	Interbedded - applied to strata of soil or beds of rock lying between or alternating with other strata of different nature
Pocket - small, erratic deposit of limited lateral extent	
Lens - lenticular deposit	

STANDARD PENETRATION TEST (ASTM D 1586) - A 2.0" outside-diameter, 1-3/8" inside-diameter, split barrel sampler is driven into undisturbed soil by means of a 140-pound weight falling freely through a vertical distance of 30 inches. The sampler is normally driven three successive 6-inch increments. The total number of blows required for the final 12 inches of penetration is the Standard Penetration Resistance (N).

Project Name: Proposed Dewatering Building






Project Location: Flint Wastewater Treatment Plant, Michigan

Project Number: 17-09002G-10

Client: Wade Trim

Date: 1/18/2017

GEOTRAN LOG OF SOIL BORING - GEOTRAN STD-2012.GDT - 2/7/18 13:57 - C:\USERS\GEOTRAN CONSULTANTS\GOOGLE DRIVE\GEOTRAN -MAIN\PROPOSALS -PROJECTS\2017\17-09002G -FLINTWWTP\REPORT\17-09002G-10.GPJ

SAMPLE DATA						PROFILE DESCRIPTION			LABORATORY DATA							
ELEV. (ft)	SAMPLE TYPE/ NUMBER	REC. (in.)	BLOWS/ 6 INCHES	STD. PEN. RESIST. N-VALUE	POCKET PEN. (psf)	GRAPHIC LOG	GROUND SURFACE ELEVATION: 717.0 ft ±		DEPTH (ft)	MOIST. CONT. (%)	DRY DENSITY (pcf)	UNCONF. COMP. ST. (psf)	ATTERBERG LIMITS		Loss on Ignition (%)	
													LIQUID LIMIT	PLASTICITY INDEX		
715	SS-1	18	14	25			716.5	TOPSOIL: Dark Brown CLAYEY SAND with Organic Matter	0.5							
										16						
	SS-2	18	4	8												
			5													
	3															
710	SS-3	14	6	14												
			6													
	6															
	8															
	SS-4	18	6	10												
			5													
	5															
705								705.0		12.0						
	SS-5	18	5	16	6500											
			7													
	9															
700																
	SS-6	0	11	25												
			10													
	15															
695																
	SS-7	18	9	35	>9000											
			16													
	19															

Stratification lines represent approximate boundaries; In-situ, transition may be gradual.

Total Drilling Depth: 38.9 ft

Drilling Contractor: DLZ/American Drilling

Driller: V. Dearing

Drilling Method:

CME 75 Truck Mounted Drilling Rig, Using 2-1/4-inch I.D. Hollow Stem Auger to End of Boring.

Backfill Procedure:

Borehole backfilled with excavated materials.

Groundwater Levels:

At Time of Drilling: 28.5 ft

End of Drilling: 7 ft ; Caved at 28 ft

Notes:

Logged By: D. Yip

Reviewed By: M. Luckham

Figure No.: 4

Project Name: Proposed Dewatering Building

Project Location: Flint Wastewater Treatment Plant, Michigan

Project Number: 17-09002G-10

Client: Wade Trim

Date: 1/18/2017

[illegible]

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Project Name: Proposed Dewatering Building









Project Location: Flint Wastewater Treatment Plant, Michigan

Project Number: 17-09002G-10

Client: Wade Trim

Date: 1/18/2018

GEOTRAN LOG OF SOIL BORING - GEOTRAN STD-2012.GDT - 2/7/18 13:57 - C:\USERS\GEOTRAN CONSULTANTS\GOOGLE DRIVE\GEOTRAN - MAIN\PROPOSALS - PROJECTS\2017\17-09002G - FLINT\WWT\REPORT\17-09002G-10.GPJ

SAMPLE DATA						PROFILE DESCRIPTION			LABORATORY DATA						
ELEV. (ft)	SAMPLE TYPE/ NUMBER	REC. (in.)	BLOWS/ 6 INCHES	STD. PEN. RESIST. N-VALUE	POCKET PEN. (psf)	GRAPHIC LOG	GROUND SURFACE ELEVATION: 716.5 ft ±	DEPTH (ft)	MOIST. CONT. (%)	DRY DENSITY (pcf)	UNCONF. COMP. ST. (psf)	ATTERBERG LIMITS		Loss on Ignition (%)	
												LIQUID LIMIT	PLASTICITY INDEX		
715			4				715.5	0							
	SS-1	18	5	14				1.0							
			9												
	SS-2	18	8	36				5							
			16												
710			20												
			6												
	SS-3	14	9	12											
			6												
			6												
	SS-4	18	3	9				10							
			3												
			6												
705															
	SS-5	18	4	13	4500			15							
			6												
			7												
700															
															
	SS-6	18	5	30	>9000			20							
			11												
			19												
	SS-7	18	5	28	>9000			25							
			12												
			16												

Stratification lines represent approximate boundaries; In-situ, transition may be gradual.

Total Drilling Depth: 38.8 ft

Drilling Contractor: DLZ/American Drilling

Driller: V. Dearing

Drilling Method:

CME 75 Truck Mounted Drilling Rig, Using 2-1/4-inch I.D. Hollow Stem
Auger to End of Boring.

Backfill Procedure:

Borehole backfilled with excavated materials.

Groundwater Levels:

At Time of Drilling: 29.5 ft

End of Drilling: 6 ft ; Caved at 26 ft

Notes:

Boring was offset from the initial location due to concrete obstruction
encountered at about 5.5 ft.

Logged By: D. Yip

Reviewed By: M. Luckham

Figure No.: 5



Project Name: Proposed Dewatering Building

Project Location: Flint Wastewater Treatment Plant, Michigan

Project Number: 17-09002G-10

Client: Wade Trim

Date: 1/18/2018

SAMPLE DATA						PROFILE DESCRIPTION			LABORATORY DATA						
ELEV. (ft)	SAMPLE TYPE/ NUMBER	REC. (in.)	BLOWS/ 6 INCHES	STD. PEN. RESIST. N-VALUE	POCKET PEN. (psf)	GRAPHIC LOG	GROUND SURFACE ELEVATION: 716.5 ft ±		DEPTH (ft)	MOIST. CONT. (%)	DRY DENSITY (pcf)	UNCONF. COMP. ST. (psf)	ATTERBERG LIMITS		Loss on Ignition (%)
													LIQUID LIMIT	PLASTICITY INDEX	
690							Very Stiff to Hard Gray SILTY CLAY with Trace of Sand, Gravel and Occasional Silty Sand Layers								
	SS-8	18	4 6 11	17	5000				30						
685								684.5		32.0					
	SS-9	5	50/5"	50/5"		35									
680						Very Dense Gray SILTY SAND with Little Clay and Gravel									
	SS-10	3	50/3"	50/3"				677.7	38.8						
	End of Boring at 38.8 ft.														
675															
670															
665															
660															

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Exhibit 3
MAK-2005 SCADA Integration Proposal

City of Flint
Flint, Michigan
WPCF 2020 Projects

Influent & Grit Battery A
MAK-2005

MAK: Michael Lancina
MAKcontrolsLLC@gmail.com
(734) 770-8785

City of Flint: John Florshinger
jflorshinger@cityofflint.com
(810) 577-8909



ELECTRICAL ENGINEERING | CONTROLS DESIGN
PANEL FABRICATION | PROJECT MANAGEMENT

MAK-2005 Influent-Grit A Rehab.xlsx

System Features & Functions



Scope

Provide engineering support to integrate the process changes necessitated by the work associated with the Influent Structure & Grit Battery A Rehabilitation project.

Justification

Grit Tank Air Flow - valve replacement w/ electric Rotork actuators, new flow metering.

Grit Pumps (x3) - replaced with new Flygt Concertor pumps w/ integral controllers.

Grit Classifier - Classifier and Control Panel (Hydro International)

Description

In addition to significant structural repair, controls for the Grit Classifier will be updated to support the new final elements - this includes the new air flow and pump controls (integrated into the plant SCADA system).

Grit Pumps (supplied by others) - the new Flygt Concertor pumps have integral 'smart' controllers. This proposal covers the integration and programming of these pumps which will communicate via ModbusTCP to the existing Grit controls.

A ModbusTCP gateway will be supplied and added to the existing CLX controller to enable comms from the Flygt pumps to the plant controls.

Air Flow (valve and flow meter by others) - The Air Flow loop will be updated with electrically actuated valves and new flow meters. This proposal covers integration and programming of these devices.

New VFDs will be supplied for the Grit Screws by others. The necessary integration and programming is part of this scope.

The Grit Classifier controls will be integrated into the Plant SCADA system. Various interlocks between the systems and sub-systems will be implemented as needed.

System commissioning support and engineering support during construction will be provided as necessary.

Project Documentation: loop sheets and operator training.

Payment Terms

MAK Controls requests the following payment terms:

Contract Award - 50%

Project Complete - 50%

The following is a lump-sum proposal for this project:

\$10,945.00

MAK-2005 Influent-Grit A Rehab.xlsx

Bill of Materials



Qty	Item	Manufacturer	Description
1	ModbusTCP Gateway	RTA	460ETCMC
Miscellaneous Hardware			
1	CCS Services Calc	MAK Controls	engineering services
Engineering Services			

MAK-2005 Influent-Grit A Rehab.xlsx

Terms and Conditions



The terms and conditions stated below shall become a part of any service agreement or contract including services by MAK Controls LLC (hereinafter "MAK Controls")

1. COMPENSATION:

Unless otherwise agreed to by MAK Controls, the Purchaser will pay MAK Controls for services rendered which shall be invoiced at the hourly rates applicable to the type of service(s) provided by the MAK Controls employee(s) during the billing period. Services shall include the travel spent to Purchaser's place of business from the office or home of the MAK Controls employees. Purchasers shall reimburse MAK Controls for reasonable out of pocket expenses as defined in Section 8. Payments must be made in full within 30 days of the dates of the invoices.

2. TAXES AND OTHER CHARGES:

The Purchaser shall pay MAK Controls an additional amount equal to any taxes, duties or charges by any governmental or quasi-governmental authority which accrues due to this contract except for taxes on net income.

3. SCOPE CHANGES:

Any changes in the scope of order other than for services or any material change in the scope of an order for services must be documented in writing by the Purchaser and subject to incorporation in the original agreement by written approval by an Officer of MAK Controls. Any of these changes authorized by Purchaser may result in price, delivery and/or condition changes. Price changes shall be on the then current rates.

4. NORMAL WORK DAY:

The normal workday shall be an eight (8) hour day shift excluding Saturdays, Sundays and holidays observed by MAK Controls.

5. OVERTIME:

Any service or travel not performed or done during a normal workday shall be invoiced at MAK Controls's overtime rate only when agreed to by Purchaser.

6. SHIFT WORK:

When shift work (eight (8) hour shifts other than the normal work day) is required, a twenty percent (20%) premium shall be added for service during the other shifts. Overtime rates plus twenty percent (20%) shall be applicable for work in excess of eight (8) hours during these other shifts.

7. ADVANCED COMMITMENTS:

Service time committed in advance by MAK Controls on the basis of a pre-specified number of days shall not be deemed to include overtime or shift work. If overtime or shift work is required on such commitments, the pre-specified time so committed in advance shall be appropriately reduced.

8. EXPENSES:

Unless otherwise agreed upon in writing, Purchaser shall reimburse MAK Controls for expenses as follows:

- A. Automobile travel expenses shall be reimbursed on the basis of the current IRS approved standard mileage rate.
- B. All other travel and living expenses shall be reimbursed at cost.
- C. Applicable communication expense accrued on the job shall be reimbursed at cost.

Travel time and expenses shall accrue from the point of origin. Airline travel shall be at Coach class unless Purchaser's needs versus seat availability dictates otherwise. Living accommodations shall be of business class quality unless unavailable in which case the next best available accommodations shall be selected.

9. DELAYS

Unless the MAK Controls representative has been released from the jobsite, or has completed his assignment, the Purchaser will pay MAK Controls charges computed as if the MAK Controls representative was working a normal work week, regardless of whether or not the representative is prevented from working due to delays beyond this control. Release from the jobsite shall entitle the representative to return to his point of origin, with travel time and expenses for the account of Purchaser.

10. STANDBY TIME:

Standby time is defined as the time during which a MAK Controls representative is requested to remain in readiness and available for work commencing at the convenience of the Purchase. Such time shall be considered as time worked, whether or not the representative is at the jobsite, and Purchaser will be billed accordingly. If standby time is outside normal working hours, overtime rates will be applicable. Standby time will be added to time actually worked for the computation of overtime

11. WORKING CONDITIONS:

The MAK Controls representative reserves the right to refuse to work under hazardous conditions. In case of doubt, mutual agreement must be reached prior to commencement of any work. All staging and rigging required for access to equipment to be serviced shall be erected by and at the expense of others and shall comply with reasonable safety requirements. The MAK Controls representative shall comply with all plant regulations where applicable. However, any clothing or equipment, except the standard safety hat, safety glasses, safety shoes, and nomex coveralls, shall be provided by Purchaser.

12. LIMITATION OF LIABILITY:

MAK Controls representatives are authorized to act only in a consulting capacity and are not authorized or licensed to operate equipment. All responsibility for operating equipment shall rest with others. Except as provided in Paragraph 14, MAK Controls shall not be liable for loss or damage of any nature.

13. TOOLS AND TEST EQUIPMENT:

The MAK Controls representative will be equipped with instruments, tools and test equipment as required to fulfill service obligations.

14. INSURANCE INDEMNITY:

MAK Controls will at Purchaser's request submit Certificates of Insurance from Sureties chosen by MAK Controls showing the limits of coverage. MAK Controls agrees to indemnify and save harmless Purchaser only against liability imposed on Purchaser by law with respect to bodily injury or property damage to the extent such liability results from the performance of MAK Controls under this contract. MAK Controls does not agree to indemnify and save Purchaser harmless except as set forth herein. Purchaser agrees to indemnify and save harmless MAK Controls for all loss, cost or damage incurred by MAK Controls as a result of Purchaser's or third party's misuse of misapplication of MAK Controls's supplied products. IN NO EVENT, REGARDLESS OF CAUSE, SHALL MAK Controls BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGE EITHER REAL OR ALLEGED.

15. MISCELLANEOUS: