

November 8, 2017

To Whom It May Concern:

The City of Dover will receive sealed bids on December 20, 2017 at 2:00 p.m. local time for the **WATER TREATMENT PLANT PROCESS IMPROVEMENT PROJECT, BID NUMBER 18-0014PW.**

There will be a mandatory Pre Bid Meeting on November 20, 2017, at the at the John W. Pitts Center, 10 Electric Avenue, Dover, DE 19904 @ 9:00 a.m. The nearest intersection is Electric Avenue and North Street.

The pre-bid meeting must be attended in order to bid on the contract. The doors will be shut at precisely 9:00 a.m. at which time no admittance will be permitted. Bidders must allow themselves sufficient time to be present prior to the start of the pre-bid meeting. Traffic and weather will not be considered a justifiable reason to be late. All prospective bidders are encouraged to download and review the specifications prior to attending the meeting.

Drawings and Specifications, including the bid forms, may be obtained on CD, in PDF format, for \$50.00 from the City of Dover Department of Public Works (DPW), 15 Lockerman Plaza, Dover, DE 19901. Drawings and Specifications Fees are **NON-REFUNDABLE**. If picking up CD at the DPW office, **please contact 302-736-7025 to provide 48 hours' notice before pickup, so that the CD will be ready upon arrival.**

The bid must be submitted in three paper copies and one electronic copy in PDF format on either a flash drive or a DVD. The electronic copy must be included in the submission package. Prices must be firm for at least 90 days. If prices are not bid as firm, the bid *may* be considered non-responsive.

Late Bids – A bid received after the closing date and time for receipt of the bids is late and shall not be considered. It is the responsibility of the bidder to ensure that the bid is received prior to the closing date and time.

All vendors must complete the Invitation to Bid notice and fax it to (302) 736-7178 if they intend to bid. Any vendor not returning the form may not receive published addenda.

Your proposal is not revocable for ninety (90) days following the response deadline indicated above.

If you have questions concerning this Invitation to Bid, they must be made in writing and addressed to the Purchasing Manager, 710 William Street, Dover, DE 19904 or emailed to doverwhse@dover.de.us. All questions must be submitted no later than **November 29, 2017**. All changes or corrections to this ITB will be handled by addenda issued by the Purchasing Manager. The receipt of all Addenda must be acknowledged in the proposal submission.

All copies of any bids/proposals submitted in response to this request shall be considered the property of the City of Dover and shall not be returned to the bidder.

Conflict of Interest Clause:

Pursuant to Dover Code, Chapter 30, Section 30-33, No city employee or official may participate on behalf of the city in the review or disposition of any matter pending before the city in which he has a personal or private interest. No city employee or official shall benefit from any contract with the city, nor solicit any contract, and shall not enter into any contract with the city (other than an employment contract). No person who has served as a city employee or official shall represent or otherwise assist any private enterprise on any matter involving the city, for a period of two years after termination of his employment or elected or appointed status with the city, if he gave an opinion, conducted an investigation or otherwise was directly and materially responsible for such matter in the course of his official duties as a city employee or official. All parties hereto declare and affirm that no officer, member, or employee of the City, and no member of its governing body, and no other public official of the City who exercises any functions or responsibilities in the review or approval of the undertaking described in this contract, or the performing of services pursuant to this contract, shall participate in any decision relating to this contract which affects his or her personal interest, or any corporation, partnership, or association in which he or she is directly or indirectly interested; nor shall any employee of the City, nor any member of its governing body, have any interest, direct or indirect, in this contract or the proceeds thereof.

Bids will be opened publicly at the time and place designated in this letter. The main purpose of the bid opening is to reveal the name(s) of the bidder(s), not to serve as a forum for determining the low bidder(s).

The contract shall be awarded within 90 days of the closing date to the bidder who is determined in writing to be most advantageous to the City. All prices must be held firm for a minimum of 90 days from the date of the bid opening. The bids, summaries, and tabulations shall not be open for public inspection until after receipt of a fully executed contract.

The City of Dover reserves the right to waive technicalities, to reject any or all bids, or any portion thereof, to advertise for new proposals, to proceed to do the work otherwise, or to abandon the work, if in the best interest of the City.

All bids are to be received by the Procurement Office, 710 William Street, Dover, DE, 19904 no later than the 2:00 p.m. bid opening. All bids will be opened in the presence of the Procurement Manager or his/her designee. All bids shall become public record and shall be available for public inspection after it has been determined that there is no proprietary information contained within the bids. Any and all proprietary information contained within the bid must be clearly

marked. The cover must indicate that the bid contains such information. **Copies** of the bids will not be provided to competing vendors.

Minority, women, veteran, service disabled veteran, and individuals with disabilities owned vendor preference shall be three percent (3%) of the value of the award. **The vendor must identify qualification and claim to the preference on the submitted proposal documents. The vendor must provide authoritative proof of minority ownership such as identification in the certification directory maintained by the State of Delaware Office of Supplier Diversity to qualify for this preference.** This preference is to be considered as a stand-alone and cannot be added to any other preference that may be allowed. This preference shall not apply to subcontractors.

Local vendor preference shall be considered for materials, equipment, construction contracts, and utility contracts. Local vendor preference shall be three percent (3%) of the value of the award. The term local vendor is defined as a gradually increasing range with preference assigned as follows:

Rule 1: Vendor located within the city limits of the City of Dover.

Rule 2: Vendor located within Kent County, Delaware (applicable only if no vendor qualifies under rule 1)

Rule 3: Vendor located within the State of Delaware (applicable only if no vendor qualifies under rules 1 & 2)

In the event that no vendor qualifies under rules 1, 2, or 3, no local vendor preference will be awarded. **The vendor must identify qualification and claim to the preference on the submitted documents.** This preference is to be considered as stand-alone and cannot be added to any other preference that may be allowed.

In the event the contractor does not fulfill its obligations under the terms and conditions of this contract, the City of Dover may contract for an equivalent product on the open market. Any difference in cost between the contract prices herein and the price of open market product shall be the responsibility of the contractor. Under no circumstances shall monies be due the contractor in the event open market products can be obtained below contract cost. Any monies charged to the contractor may be deducted from an open invoice.

Neither the contractor nor the City of Dover shall be held liable for non-performance under the terms and conditions of this contract due, but not limited to, government restriction, strike, flood, fire, or unforeseen catastrophe beyond either party's control. Each party shall notify the other in writing of any situation that may prevent performance under the terms and conditions of this contract.

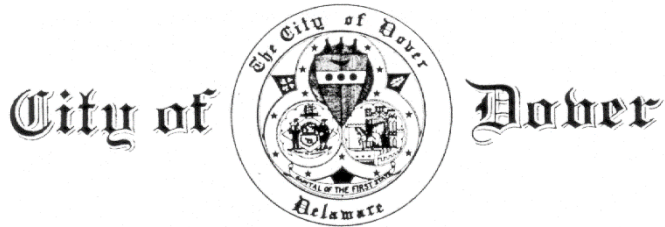
Vendors must provide references to the City of Dover upon request. Vendor references may be checked to verify their ability to perform the contract requirements, the quality of work and the ability to meet obligations.

ENVELOPES MUST BE MARKED "WATER TREATMENT PLANT PROCESS IMPROVEMENT PROJECT, BID NUMBER 18-0014PW BID OPENING DECEMBER 20, 2017, 2:00 P.M." No faxed or electronic bids will be accepted.

The City of Dover shall have the right to reject any or all bids if deemed to be in the best interest of the City, such as but not limited to local vendor preference and minority vendor preference while awarding bids.

Sincerely,

Peter K. Gregg
Contract and Procurement Manager
City of Dover
(302) 736-7795
Fax (302) 736-7178
Pgregg@dover.de.us
www.cityofdover.com/bid-procurement



INVITATION TO BID NOTICE

Bid Number: 18-0014PW

Bid Opening: December 20, 2017, 2:00 p.m.

Description: Water Treatment Plant Process Improvement Project

If you are interested in the invitation to bid described above, you can download the instructions in Adobe PDF format from our web site <http://www.cityofdover.com/bid-procurement>. Any amendments of other additional information related to this solicitation will be posted with the original document on the web site.

If you do not have internet access and want to receive this request for proposal, all subsequent amendments, or additional information on the bid package, please provide the requested information to:

The City of Dover
 Purchasing Office
 710 William Street
 Dover, DE 19904
 Fax: (302) 736-7178, attention Peter Gregg
 Phone: (302) 736-7795
 e-mail: pgregg@dover.de.us

Please complete the following and return this form to Central Services:

Company:	Vendor Response /Request
Address	No bid at this time, please retain on bid list
	Please send complete Bid/RFP package
Contact:	I will download the Bid/RFP package
Phone	I intend to bid
Fax	I do not intend to bid
e-mail for ITB/RFP	Other:

CITY OF DOVER, DELAWARE
INVITATION TO BID
Water Treatment Plant Process Improvements
November 2017
BID NUMBER: 18-0014PW



Issued By:
City of Dover
Purchasing Office
710 William Street
Dover, Delaware 19904
(302) 736-7046
Fax (302) 736-7178



Prepared by:
AECOM
4051 Ogletown Road, Suite 300
Newark, DE 19713
(302) 781-5900

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Geotechnical Investigation Long Point Water Treatment Plant Upgrades (AECOM)

INVITATION TO BIDDERS

BID NUMBER: 18-0014PW

Sealed Bids, three (3) paper copies and one (1) electronic copy, will be received by the City of Dover, City of Dover Procurement Office, 710 William Street, Dover, DE 19904 no later than **2:00 P.M.** on December 20, 2017 for the **Water Treatment Plant Process Improvement Project**, at which time the bids will be opened publicly and read aloud.

- Drawings and Specifications, including the bid forms, may be obtained on CD, in PDF format, for \$50.00 from the City of Dover Department of Public Works, 15 Loockerman Plaza, Dover, DE 19901. Drawings and Specifications Fees are **NON-REFUNDABLE**. If picking up CD at the DPW office, **please contact 302-736-7025 to provide 48 hours' notice before pickup so that the CD will be ready upon arrival.**
- Specifications, including the bid forms, will be available on the City of Dover's procurement website (<http://www.cityofdover.com/Bid-Procurement/>). The Contractor is responsible for all printing costs if so desired.
- A copy of the Drawings and Specifications will be held at the City of Dover Department of Public Works, 15 Loockerman Plaza, Dover, DE 19903 for review.

I. NAME OF SOLICITING GOVERNMENT

**City of Dover, Delaware
City Hall – The Plaza
P.O. Box 475
Dover, Delaware 19903-0475**

II. PURPOSE OF REQUEST

- A. The work under this project includes renovations to the existing water treatment plant complete with pumps, valving, piping, site work and electrical improvements, and construction of new treatment buildings, tanks, and sand drying beds. It is anticipated that this project will be completed within three hundred sixty (360) calendar days.
- B. The Contractor shall and will furnish and deliver to the City all labor, materials and equipment to successfully complete the work of this Contract, of which all construction documents are a part, and which is generally described as the Contract Documents for Water Treatment Plant Process Improvement Project, Bid No. 18-0014PW.
- C. The City of Dover (the City) invites written bids from qualified contractors that are interested in providing services, as outlined below.

III. SCOPE OF WORK

- A. The work to be done is covered in the Construction Documents (Drawings) titled Water Treatment Plant Process Improvements Project and in the project technical specifications titled Water Treatment Plant Process Improvements Project.
- B. All implements, machinery, tools, erosion and sediment control, equipment, and material shall be provided by the contractor, including the labor necessary for everything necessary to make the work perfect, complete, neat and finished. The Contractor shall leave all the work to be done under this Contract in this condition at the time the work is finally inspected.

IV. STATEMENT OF QUALIFICATIONS (SOQ)

- A. All contractors submitting bids shall include the following: a current financial statement, an acceptable experience record, an acceptable equipment schedule and any other documents deemed necessary by the City of Dover. Below is a detailed list of the items that must be submitted to the City of Dover on the date of the bid opening.
1. Business name and contact person, together with the address, telephone number, facsimile number and email address, of the office from which the services will be provided.
 2. Proof of insurance, complying with the **Instructions to Bidders** Section, including the following documentation:
 - Certificate of Insurance
 - Declaration Page
 - Insurance policy documents
 3. A financial statement prepared by an independent certified public accountant or an independent public accountant holding a valid permit issued by an appropriate State licensing agency and shall have been so prepared as to reflect the financial status of the submitting company. This statement must be current and not more than one (1) year old. In the case that the bid date falls within the time that a new statement is being prepared, the previous statement shall be updated by proper verification.
 4. Identify the personnel who will manage and supervise this project, as well as the staff responsible for jobsite safety, quality control and other specialties. Provide each person's title and project-specific responsibilities, and resume. Lack of detailed information on the resumes may result in a less favorable evaluation. Provide an organization chart diagram if necessary to clearly explain the lines of authority, duties & responsibilities.
 5. The bidder shall provide documentation showing satisfactory performance as the prime contractor (General Contractor) responsible for the complete construction of five (5) similar projects within the past five (5) years. Projects considered "similar" are defined as those with two or more of the following characteristics:
 - Experience in construction of similar sized water plant projects
 - Experience in construction of any sized water plant projects
 - Experience with water treatment plant construction in the State of Delaware
 - Bidders past performance and experience working with proposed subcontractors
 - Contractor's understanding of the project's intent, goals and objectives
 5. Documentation that the business is licensed, insured and authorized to do work in the State of Delaware and the City of Dover.
 6. A minimum of three (3) references must be provided. Governmental references preferred. For each reference listed, the information provided should consist of the following:

(1) **Name and mailing address of the owner/business**

(2) Name and telephone number of your contact person within said business

Provide a list of references the City may contact in order to assist in the evaluation of your past performance. Please limit these references to owners of projects that involved the installation of pump stations.

7. The City's plan is to complete the proposed work by the end of August 2018. Provide documentation stating that your business has the available equipment, manpower resources and ability to meet the proposed schedule.
8. Provide documentation that shows that your business has a current safety plan and or policy in place and conducts periodic safety training.
9. Information on the nature and magnitude of any litigation or proceeding whereby, during the past three (3) years, a court or any administrative agency has ruled against the bidder in any matter related to the professional activities of the bidder. Similar information shall be provided for any current or pending litigation or proceeding.
10. A statement to the effect that the selection of the bidder shall not result in a conflict of interest with any other party which may be affected by the work to be undertaken. Should any potential or existing conflict be known by a bidder, said bidder must specify the party with which the conflict exists or might arise, the nature of the conflict, and whether or not the proposer would step aside or resign from the engagement or representation creating the conflict. (The City reserves the right to select more than one firm to perform the required services to avoid conflict of interest and other similar occurrences.)
11. Any additional information that you feel will be beneficial to the City in evaluating your qualifications to perform the proposed scope of work.

V. COMPENSATION

- A. The bid should clearly state the fee to be charged for the proposed work and should be provided on the Bid Form.
- B. **The most current State of Delaware Prevailing Wage Rates and the Federal Davis Bacon Wage Rates shall apply to this contract. Payroll verification must be submitted on a weekly basis. Failure of the Contractor to provide this information will result in the removal of the contractor from the jobsite until this obligation has been met. The applicable prevailing wage rates are provided in Supplementary Conditions.**

END OF SECTION ITB

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INSTRUCTIONS TO BIDDERS

I. BID SUBMISSION

A. All bids should be delivered to:

**Peter Gregg
Contract and Procurement Manager
City of Dover
710 William Street
Dover, Delaware 19904**

B. Questions regarding scope of services or bid process:

1. To ensure fair consideration for all bidders, communication to or with any department or departmental staff during the submission process, will be prohibited except as provided in the third paragraph below. Any communication between proposer and the City will be initiated by the appropriate staff member in order to obtain information or clarification needed to develop a proper, accurate evaluation of the bid. Such communications initiated by a bidder may be grounds for disqualifying the offending bidder from consideration for award of the bid and/or any future bid.
2. Any questions relative to interpretation of the scope of services or the bid process, shall be addressed as indicated below, in ample time before the period set for the receipt and opening of bids.
3. Questions or comments should be directed **in writing** to:

**Peter Gregg
Contract and Procurement Manager
City of Dover
710 William Street
Dover, Delaware 19904
Facsimile Number: (302) 736-7178
E-mail address: doverwhse@dover.de.us**

Email is the preferred method of receiving questions.

- C. In order to be acceptable, **three (3) paper copies and one (1) electronic copy of the bid must be submitted in a sealed envelope on the outside of which shall be plainly marked "Sealed Bid: Water Treatment Plant Process Improvements ITB Bid Opening Wednesday, December 20, 2017, 2:00 P.M. Bid No.: 18-0014PW"**, together with the name, address, and license number, if applicable, of the company submitting the bid. Bids will be received until **2:00 P.M.** or hand delivered no later than **2:00 P.M.** on **Wednesday, December 20, 2017**, at which time they will be publicly opened in the **City of Dover Purchasing Office, 710 William Street, Dover, Delaware 19904**.
- D. Bidders are fully responsible for the timely delivery of bids. Late bids will not be accepted and will be returned to the proposer unopened. Telegraph, telephone, facsimile machine, and electronic mail proposals will not be accepted under any circumstances.
- E. In the event that personal interviews are deemed necessary, and your business is included among those selected for interview, you will be contacted in order to schedule a mutually agreeable date and time for the interview.

- F. It is anticipated that a final decision on the business to be selected will be made within 30 days or upon approval by City Council, whichever occurs earlier. All bidders will subsequently be contacted and advised of the Department's decision.

II. TERMS AND CONDITIONS

- A. The City reserves the right to reject any or all bids, with or without cause, to waive technicalities, or to accept the bid, which in its judgment best serves the interests of the City. The City further reserves the right to award the contract to the next most qualified bidder if the successful bidder does not execute a contract within thirty (30) days after being notified of the award of the bid.
- B. The City reserves the right to request clarification of information submitted and to request additional information from one or more bidders. All costs associated with the presentation of the proposal and any supplemental information shall be borne solely by the bidder, and shall not be passed on to the City under any circumstances.
- C. Any bid may be withdrawn until the date and time stated above for the opening of the bids. Any bids not so withdrawn shall constitute an irrevocable offer to sell to the City the services indicated for a period of ninety (90) days, or until one or more of the bids have been accepted by the Department, whichever occurs earlier.
- D. Any written agreement or contract resulting from the acceptance of a bid shall be prepared on forms either supplied by or approved by the City, and shall contain, at a minimum, applicable provisions of this request for proposals. The City reserves the right to reject any agreement that does not conform to the request for proposals or any other City requirements for agreements and contracts. The following are representative of the provisions to be included within the contract documents:
1. Termination - If through any cause, the firm selected shall fail to fulfill the obligations agreed to in a timely and efficient manner, the City shall have the right to terminate the contract by specifying the date of termination in a written notice to the firm at least thirty (30) days before the termination date. In this event, the firm shall be entitled to just and equitable compensation for the work satisfactorily completed.
 2. Assignment - The bidder shall not assign any interest in the contract, and shall not transfer any interest in the same without the prior written consent of the City.
 3. Non-discrimination - The successful proposer must specify in the contract that the firm will not discriminate under the contract, against any person as provided in any federal, state, or local government laws and regulations.
 4. Certificate of Insurance - The contractor selected must present proof of insurance coverage of a nature and amount deemed adequate by the City, and be willing to execute a hold harmless indemnification for the City.
 5. Publication of Information - No reports, information, or data given to or prepared by the firm under the contract shall be made available to any individual or organization by the firm without the prior written approval of the City. This provision shall only apply insofar as it does not conflict with the provisions of the Freedom of Information Act.
- E. The successful Bidder shall be required to enter into a contract with the City of Dover which shall reflect the services requested in the Invitation to Bid, without delay upon notice of award of contract.

III. INSURANCE REQUIREMENTS

A. Policies Required. At all times during the term of this Project Bid No. **18-0014PW**, the Contractor shall keep in force and affect all insurance policies as described below:

- Worker's Compensation and Employers' Liability Insurance. Statutory worker's compensation benefits and employers' liability insurance with a limit of liability no less than that required by Delaware law at the time of the application of this provision for each accident. This policy shall be endorsed to include a waiver of subrogation in favor of the City of Dover. The Contractor shall require subcontractors and others not protected under its insurance to obtain and maintain such insurance.
- Commercial General Liability Insurance. Policy will be written to provide coverage for, but not limited to, the following: premises and operations, products and completed operations, personal injury, blanket contractual coverage, broad form property damage, independent contractor's coverage with Limits of liability not less than \$1,000,000 general aggregate, \$1,000,000 products/completed operations aggregate, \$1,000,000 personal injury, \$2,000,000 each occurrence.
- Automobile Liability Insurance. Business automobile policy covering all owned, hired and non-owned private passenger autos and commercial vehicles. Limits of liability not less than \$1,000,000 each occurrence, \$1,000,000 aggregate.
- Qualification; Priority; Contractors' Coverage. The insurer must be authorized to do business under the laws of the State of Delaware. Such insurance will be primary. All contractors and all of their subcontractors who perform work on behalf of Contractor shall be responsible for carrying, in full force and effect, worker's compensation and employer's liability, and automobile liability insurance coverage.
- Certificate of Insurance; Other Requirements. At the execution of this Agreement and prior to each insurance policy expiration date during the term of this Agreement, Contractor will furnish the City of Dover with a Certificate of Insurance with the CITY named as an additional insured. The Certificate shall reference this Agreement and worker's compensation and property insurance waivers of subrogation required by this Agreement. City of Dover shall be given thirty (30) calendar days advance notice of cancellation or nonrenewal of insurance during the term of this Agreement.
- Limits. The limits of liability set out in this Agreement may be increased by mutual consent of the parties, which consent will not be unreasonably withheld by either party, in the event of any factors or occurrences, including substantial increases in the level of jury verdicts or judgments or the passage of state, federal or other governmental compensation plans, or laws which would materially increase the City of Dover's exposure to risk.
- Deductible/Self-insurance Retention Amounts. Contractor shall be fully responsible for any deductible or self-insured retention amounts contained in its insurance program or for any deficiencies in the amounts of insurance maintained.

V. BID PROCESS SCHEDULE

A. The City will use the following tentative timetable in the selection process:

Date	Event
Wednesday, November 8, 2017 and Wednesday, November 15, 2017	Publicly Advertise ITB # 18-0014PW.
Monday, November 20, 2017	Pre-bid Meeting to be held at the John W. Pitts Center, 10 Electric Avenue, Dover, DE 19904 @ 9:00 a.m. The doors will be locked at 9:00 am!
Wednesday, November 29, 2017	Deadline for submitting questions and “or equal” items
Wednesday, December 6, 2017	Addendum issued/answers to bidder questions published.
Wednesday, December 20, 2017	BID OPENING Deadline to submit final bids (Bid Opening). (3 original copies by 2:00 pm)
Friday, January 26, 2018	City Completes Evaluation of Bids
Tuesday, February 13, 2018	City Issues Notice of Award
Tuesday, March 20, 2018	Notice to Proceed

END OF SECTION IB

INFORMATION FOR BIDDERS

Bids will be received by the City of Dover (herein called the "OWNER") at the City of Dover, City of Dover Central Services Department, 710 William Street, Dover, Delaware 19904, at the date and time stated in the Invitation to Bidders.

- A. Each bid must be submitted in a sealed envelope, addressed to the City of Dover, Attn: Mr. Peter Gregg, City of Dover Central Services Department, 710 William Street, Dover, Delaware 19904. Each sealed envelope containing a BID must be plainly marked "Sealed Bid: Water Treatment Plant Process Improvements ITB Bid Opening Wednesday, December 20, 2017 at 2:00 P.M. Bid No.: **18-0014PW** " and the envelope should bear on the outside the name of the BIDDER, his address, his license number, if applicable, and the name of the project for which the BID is submitted. If forwarded by mail, the sealed envelope containing the BID must be enclosed in another envelope addressed to the OWNER at the City of Dover, 710 William Street, Dover, Delaware 19904.
- B. All BIDS must be made on the required Bid form. All blank spaces for bid prices must be filled in, in ink or typewritten, and the Bid form must be fully completed and executed when submitted. Three (3) hard copies and one digital copy of the Bid form are required.
- C. The OWNER may waive any informalities or minor defects or reject any and all bids. Any bid may be withdrawn prior to the above scheduled time for the opening of BIDS or authorized postponement thereof. Any proposal received after the time and date specified shall not be considered. No BIDDER may withdraw a proposal within ninety (90) days after the actual date of the opening thereof. Should there be reasons why the contract cannot be awarded within the specified period; the time may be extended by mutual agreement between the OWNER and the BIDDER.
- D. BIDDERS must satisfy themselves of the accuracy of the estimated quantities in the BID Schedule by examination of the site and review of the drawings and specifications including ADDENDA.
- E. Products or equipment of manufactures not named in the specifications may be bid as an "or equal" only after written acceptance of the product or equipment in an addendum. The evaluation of the bids will be based on using only the named manufacturers unless costs exceed available funds. BIDDER shall list manufacturers of major products and equipment in conformance with specified equipment.
- F. After bids have been submitted, the BIDDER shall not assert that there was a misunderstanding concerning the quantities of WORK or of the nature of the WORK to be done.
- G. The OWNER shall provide to BIDDERS prior to BIDDING, all information which is pertinent to, and delineates and describes, the land owned and rights-of-way acquired or to be acquired.
- H. The CONTRACT DOCUMENTS contain the provisions required for the construction of the PROJECT. Information obtained from an officer, agent, or employee of the OWNER or any

other person shall not affect the risks or obligations assumed by the CONTRACTOR or relieve him from fulfilling any of the conditions of the contract.

- I. Each bid must be accompanied by a BID BOND payable to the OWNER in the amount of ten (10%) percent of the total amount of the BID. When the Agreement is executed the BID BONDS of the unsuccessful BIDDERS will be returned. A certified check may be used in lieu of a BID BOND.
- J. A PERFORMANCE BOND in the amount of one hundred (100%) percent of the CONTRACT PRICE, with a corporate surety approval by the OWNER, will be required for the faithful performance of the contract.
- K. Attorneys-in-fact who sign BID BOND and/or PERFORMANCE BOND must file with each BOND a certified and effective dated copy of their power of attorney.
- L. The party to whom the contract is awarded will be required to execute the Agreement and obtain the PERFORMANCE BOND within ten (10) calendar days from the date when NOTICE OF AWARD is delivered to the BIDDER. The NOTICE OF AWARD shall be accompanied by the necessary Agreement and BOND forms. In case of failure of the BIDDER to execute the Agreement, the OWNER may at his option consider the BIDDER in default, in which case the BID BOND accompanying the proposal shall become the property of the OWNER.
- M. The OWNER shall, within ten (10) days of receipt of acceptable PERFORMANCE BOND, and Agreement signed by the party to whom the Agreement was awarded, sign the Agreement and return to such party an executed duplicate of the Agreement. Should the OWNER not execute the Agreement within such period, the BIDDER may by WRITTEN NOTICE withdraw his signed Agreement. Such notice of withdrawal shall be effective upon receipt of the notice by the OWNER.
- N. The NOTICE TO PROCEED shall be issued within ten (10) days of the execution of the Agreement by the OWNER. Should there be reasons why the NOTICE TO PROCEED cannot be issued within such period, the time may be extended by mutual agreement between the OWNER and the CONTRACTOR.
- O. The OWNER may take such investigations as he deems necessary to determine the ability of the BIDDER to perform the WORK, and the BIDDER shall furnish to the OWNER all such information and data for this purpose as the OWNER may request. The OWNER reserves the right to reject any and BID if the evidence submitted by, or investigation of, such BIDDER fails to satisfy the OWNER that such BIDDER is properly qualified to carry out the obligations of the Agreement and to complete the WORK contemplated therein.
- P. To demonstrate qualifications for performing the WORK identified within the CONTRACT DOCUMENTS, BIDDERS have been requested to submit written evidence of financial position, previous experience, current commitments, and license to perform work in the State of Delaware as stated in the Invitation to Bidders. Failure to submit the requested information will be deemed sufficient to disqualify the BIDDER.

- Q. A conditional or qualified BID will not be accepted. Award will be made to the lowest responsible BIDDER.
- R. All applicable laws, ordinances, and the rules and regulations of all authorities having jurisdiction over construction of the PROJECT shall apply to the contract throughout.
- S. Each BIDDER is responsible for inspecting the site and for reading and being thoroughly familiar with the CONTRACT DOCUMENTS. The failure or omission of any BIDDER to do any of the foregoing shall in no way relieve any BIDDER from any obligation in respect to his BID.
- T. The low BIDDER shall supply the names and addresses of major material SUPPLIERS and SUBCONTRACTORS when requested to do so by the OWNER.
- U. The ENGINEER is AECOM Attn: AECOM,
Sabre Building Suite 300
4051 Ogletown Rd,
Phone: 302-781-5900

END OF SECTION IFB

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WATER TREATMENT PLANT PROCESS IMPROVEMENTS

CITY OF DOVER, DELAWARE

BID FORM

Date: _____

Bid of _____ (hereinafter called "BIDDER"), organized and existing under the laws of the State of Delaware doing business as _____. * To the City of Dover (hereinafter called "OWNER").

In compliance with the Invitation to Bidders, the BIDDER hereby proposes to perform all WORK for the **Water Treatment Plant Process Improvements**, Bid No. 18-0014PW, in strict accordance with the CONTRACT DOCUMENTS, within the time set forth therein, and at the prices stated below. The BIDDER has examined the Drawings and Specifications with related documents and the site of the proposed work, being familiar with all of the conditions surrounding the construction of the proposed project including materials and supplies, and to construct the project in accordance with the CONTRACT DOCUMENTS at the price stated below. The price is to cover all expenses incurred in performing the work required under the Contract Documents of which this Bid is a part.

The BIDDER declares that the attached Specifications and the Drawings therein referred to have been carefully examined and are understood. It is proposed and agreed if the Bid is accepted to contract with the City of Dover the required work in the manner set forth in the Specifications and shown by the Drawings.

*Corporation, Partnership, or Individual as applicable.

BIDDER hereby agrees to commence WORK under this contract on or before a date to be specified in the NOTICE TO PROCEED and to fully complete the PROJECT within three hundred sixty (360) calendar days thereafter. Liquidated damages of \$500 per day will be in effect with this PROJECT, refer to Section 00 73 00, paragraph 1.03.

BIDDER acknowledges receipt of the following ADDENDUM (if applicable):

_____	_____
_____	_____
_____	_____
_____	_____

The BIDDER declares that the only person, firm or corporation, or persons, firms or corporations, that has or have any interest in this bid or in the Contract or Contracts proposed to be taken is or are the undersigned; that this bid is made without any connection or collusion with any person, firm or corporation, making a bid for the same work.

BIDDER agrees to perform all the work described in the CONTRACT DOCUMENTS for the following lump sum:

_____ Dollars (\$_____).

- Items to be included with Bid: _____ Completed Bid Form (3 Copies)
_____ Bidders Statement of Qualifications
_____ Bid Bond (10% of the total amount of the BID)

The bidder agrees that this bid shall be good and may not be withdrawn for a period of 90 calendar days after the scheduled closing time for receiving bids. Upon receipt of written notice of the acceptance of this bid, bidder will execute the formal contract attached within 10 days and deliver.

The names and addresses of all members of a firm or the names, addresses, and titles of every officer of a corporation as the case may be, must be given here by the member if the firm or by the officer or agent of the corporation who signs the Bid.

Respectfully submitted:

_____ Signature	_____ Company Name
_____ Title	_____ Address
_____ Date	_____
_____ License Number (if applicable)	_____ Telephone No.

SEAL – (If BID is by a corporation)

If a Partnership, state names and addresses of Partners here:

_____	_____
_____	_____
_____	_____

Note:

Contractor shall supply documentation to answer all requirements in the statement of Qualification section, located in Section ITB.

Local Vendor Preference

Circle One: Rule 1 Rule 2 Rule 3 None

Minority Vendor Preference

Circle One: Yes No

END OF SECTION BF

BID BOND

KNOW ALL MEN BY THESE PRESENTS, that we, the Undersigned

_____ as

Principal, and _____ as Surety, are

Hereby held and firmly bound unto the City of Dover, as OWNER, the penal sum of

_____ (\$_____)

for the payment of which, well and truly to be made, we hereby jointly and severally bind ourselves,

successors and assigns. Signed, this _____ day of _____ 201_.

The Condition of the above obligation is such that whereas the Principal has submitted to the City of Dover a certain BID, attached hereto and hereby made a part hereof to enter into a contract in writing, for the Installation of the **Water Treatment Plant Process Improvements, Bid No.: 18-0014PW**.

NOW, THEREFORE,

- a) If said BID shall be rejected, or
- b) If said BID shall be accepted and the Principal shall execute and deliver a contract in the Form of Contract attachment hereto (properly completed in accordance with said BID) and shall furnish a BOND for faithful performance of said contract, and for the payment of all persons performing labor and furnishing materials in connection therewith, and shall in all other respects perform the agreement created by the acceptance of said BID, then this obligation shall be void, otherwise the same shall remain in force and effect; it being expressly understood and agreed that the liability of the Surety for any and all claims hereunder shall, in no event, exceed the penal amount of this obligation as herein stated.

The Surety, for value received, hereby stipulates and agrees that the obligations of said Surety and its BOND shall be in no way impaired or affected by any extension of the time within which the owner may accept such BID; and said Surety does hereby waive notice of any extension.

In WITNESS WHEREOF, the Principal and the Surety have hereunto set their hands and seals, and such of them as are corporations have caused their corporate seals to be hereto affixed and these presents to be signed by their proper officers, the day and year first set forth above. Surety executing Bonds shall be a licensed agent in the State of Delaware.

_____ (L.S.)

Principal

Surety

By: _____

IMPORTANT – Surety companies executing BONDS must appear on the Treasury Department’s most current list (Circular 570 as amended) and be authorized to transact business in the state where the project is located.

END OF SECTION BB

AGREEMENT FOR CONSTRUCTION CONTRACT

THIS AGREEMENT is made as of the ____ day of _____ in the year 201__, between The City of Dover, a Delaware Municipal Corporation, whose address is 15 East Lookerman Plaza, Dover, Delaware 19903 (hereinafter referred to as the CITY), and _____ (COMPANY NAME), whose address is, _____ (hereinafter referred to as the CONTRACTOR).

NOW, THEREFORE, in consideration of the mutual benefits accruing to the parties to this Agreement, and for other good and valuable considerations, the parties agree as follows:

1. SERVICES

The CONTRACTOR shall perform the following services for **Water Treatment Plant Process Improvements, Bid No.: 18-0014PW**.

Nothing herein shall limit the CITY's right to obtain proposals or services from other professionals for similar projects at any time the City so chooses.

2. INDEMNIFICATION

The Contractor, and any agent or subcontractor, shall defend, indemnify and hold harmless the City of Dover and its officials, officers, board members, council members, commissioners, representatives, employees, agents, and contractors, against any and all liability, costs, damages, fines, taxes, special charges by others, penalties, payments (including payments made under any Workers' Compensation Laws or under any plan for employees' disability and death benefits), and expenses (including reasonable attorney fees of the City of Dover and all other costs and expenses of litigation). Claims arising in any way, including any act, omission, failure, negligence or willful misconduct, in connection with the work, construction, maintenance, repair, presence, use, or operation by Contractor, or Contractors officers, directors, employees, agents, and sub-contractors, shall be responsible for Claims. Such Claims include, but are not limited to, the following:

- a. Intellectual property infringement, libel and slander, trespass, unauthorized use of television or radio broadcast programs and other program material, and infringement of patents;
- b. Cost of work performed by City of Dover that was necessitated by Contractors failure, or the failure of Contractors officers, directors, employees, agents, or sub-contractors, to perform work, or maintain City of Dover facilities in accordance with the requirements and specifications of this Agreement, or from any other work authorized under this Agreement;
- c. Damage to property, injury to or death of any person arising out of the performance or nonperformance of any work or obligation undertaken by Contractor, or Contractors officers, directors, employees, agents, and sub-contractors, pursuant to this Agreement;

3. PROCEDURE FOR INDEMNIFICATION

- a. City of Dover shall give notice promptly to Contractor of any claim or threatened claim, specifying the factual basis for such claim and the amount of the claim. If the claim relates to an action, suit or proceeding filed by a third party against City of Dover, the notice shall be given to Contractor by City of Dover no later than ten (10) calendar days after written notice of the action, suit or proceeding was received by City of Dover.
- b. Failure to timely give the required notice will not relieve the Contractor from its obligation to indemnify the City of Dover unless the City of Dover is materially prejudiced by such failure.
- c. The City of Dover will have the right at any time, by notice to the Contractor, to participate in or assume control of the defense of the claim with counsel of its choice, which counsel must be reasonably acceptable to the Contractor. The Contractor agrees to cooperate fully with the City of Dover. If the City of Dover so assumes control of the defense of any third-party claim, the Contractor shall have the right to participate in the defense at its own expense. If the Contractor does not so assume control or otherwise participate in the defense of any third-party claim, it shall be bound by the results obtained by the City of Dover with respect to the claim.
- d. If the City of Dover assumes the defense of a third-party claim as described above, then in no event will the City of Dover admit any liability with respect to, or settle, compromise or discharge, any third party claim without the Contractors prior written consent, and the Contractor will agree to any settlement, compromise or discharge of any third-party claim which the City of Dover may recommend which releases the City of Dover completely from such claim.
- e. Municipal Liability Limits. No provision of this Agreement is intended, or shall be construed, to be a waiver for any purpose by either Utility of any applicable State limits on municipal liability.
- f. Disclaimer. The City of Dover makes no express or implied warranties with regard to its structures, fixtures, materials, or other equipment, all of which are hereby disclaimed. The City of Dover makes no other express or implied warranties, except to the extent expressly set forth in this Agreement. The City of Dover expressly disclaims any implied warranties of merchantability or fitness for a particular purpose.
- g. Duty to Competent Supervision and Performance. The Contractor shall ensure that its employees, servants, agents, and subcontractors have the necessary qualifications, skill, knowledge, training, and experience to protect themselves, their fellow employees, employees of the Utility, and the general public, from harm or injury while performing work permitted pursuant to this Agreement. In addition, the Contractor shall furnish its employees, servants, agents, and subcontractors with competent supervision and sufficient and adequate tools and equipment for their work to be performed in a safe manner.
- h. Duty to Inform. The Contractor further warrants that it understands the imminent dangers (INCLUDING SERIOUS BODILY INJURY OR DEATH FROM FALLING) inherent in the work necessary to perform the work expected under this agreement by Contractors employees, servants, agents, contractors or subcontractors, and accepts as its

duty and sole responsibility to notify and inform Contractors employees, servants, agents, contractors or subcontractors of such dangers, and to keep them informed regarding same.

4. INSURANCE

- a. Policies Required. At all times during the term of this Agreement, the Contractor shall keep in force and affect all insurance policies as described below:
- b. Worker's Compensation and Employers' Liability Insurance. Statutory worker's compensation benefits and employers' liability insurance with a limit of liability no less than that required by Delaware law at the time of the application of this provision for each accident. This policy shall be endorsed to include a waiver of subrogation in favor of the City of Dover. The Contractor shall require subcontractors and others not protected under its insurance to obtain and maintain such insurance.
- c. Commercial General Liability Insurance. Policy will be written to provide coverage for, but not limited to, the following: premises and operations, products and completed operations, personal injury, blanket contractual coverage, broad form property damage, independent contractor's coverage with Limits of liability not less than \$1,000,000 general aggregate, \$1,000,000 products/completed operations aggregate, \$1,000,000 personal injury, \$2,000,000 each occurrence.
- d. Automobile Liability Insurance. Business automobile policy covering all owned, hired and non-owned private passenger autos and commercial vehicles. Limits of liability not less than \$1,000,000 each occurrence, \$1,000,000 aggregate.
- e. Qualification; Priority; Contractors' Coverage. The insurer must be authorized to do business under the laws of the State of Delaware. Such insurance will be primary. All contractors and all of their subcontractors who perform work on behalf of Contractor shall be responsible for carrying, in full force and effect, worker's compensation and employer's liability, and automobile liability insurance coverage.
- f. Certificate of Insurance; Other Requirements. At the execution of this Agreement and prior to each insurance policy expiration date during the term of this Agreement, Contractor will furnish the City of Dover with a Certificate of Insurance with the CITY named as an additional insured. The Certificate shall reference this Agreement and worker's compensation and property insurance waivers of subrogation required by this Agreement. City of Dover shall be given thirty (30) calendar days advance notice of cancellation or nonrenewal of insurance during the term of this Agreement.
- g. Limits. The limits of liability set out in this Agreement may be increased by mutual consent of the parties, which consent will not be unreasonably withheld by either party, in the event of any factors or occurrences, including substantial increases in the level of jury verdicts or judgments or the passage of state, federal or other governmental compensation plans, or laws which would materially increase the City of Dover's exposure to risk.
- h. Deductible/Self-insurance Retention Amounts. Contractor shall be fully responsible for any deductible or self-insured retention amounts contained in its insurance program or for any deficiencies in the amounts of insurance maintained.

5. CODES, LAWS, AND REGULATIONS

The CONTRACTOR will comply with all applicable codes, laws, regulations, standards, and ordinances in force during the term of this Agreement.

6. PERMITS, LICENSES, AND FEES

The CONTRACTOR will obtain and pay for all permits and licenses required by law that are associated with the CONTRACTOR performance of the Scope of Services.

7. ACCESS TO RECORDS

The CONTRACTOR will maintain accounting records, in accordance with generally accepted accounting principles and practices, to substantiate all invoiced amounts. Said records will be available for examination by the CITY during the CONTRACTOR's normal business hours. Said records will be maintained for a period of three (3) years after the date of the invoice.

8. CONTINGENT FEES PROHIBITED

The CONTRACTOR warrants that he or she has not employed or retained any company or person, other than a bona fide employee working solely for the CONTRACTOR, to solicit or secure this Agreement and that he or she has not paid or agreed to pay any person, company, corporation, individual, or firm, other than a bona fide employee working solely for the CONTRACTOR any fee, commission, percentage, gift, or other consideration contingent upon or resulting from the award or making of this Agreement. In the event of a breach of this provision, the CITY shall have the right to terminate this Agreement without further liability and at its discretion, deduct from the contract price, or otherwise recover, the full amount of any such fee, commission, percentage, gift or consideration paid in breach of this Agreement.

9. PAYMENT

It is understood and agreed by and between the parties hereto that this Contract is in the amount of

_____ and _____ Dollars [\$_____]
as per the Bid submitted by the

Contractor on _____, 201__, and accepted by the City. The Contractor shall submit an invoice on or about the 15th of each month in which the Contract is in effect for the work completed and verified to date. The City shall pay the Contractor's invoice, less 10% retainage, within thirty (30) days of receipt. The application for payment shall include a description and verification of work completed by the Contractor. All requests for payment shall be submitted on the AIA Document G702 (Application Certificate for Payment) and be accompanied by supporting documentation which will include the percent complete on the bid items identified in the Bid Form. Dates of testing and start-up should be provided to the City as required supporting documentation. Any reimbursement for expenses shall include receipts or copies of the invoices. No other costs or services shall be billed to the CITY.

10. INDEPENDENT CONTRACTOR

The CONTRACTOR is an independent contractor and as such will be responsible for paying his own Federal income tax and self-employment tax, or any other taxes applicable to the compensation paid under this agreement.

11. ASSIGNMENT

Neither party shall have the power to assign any of the duties or rights or any claim arising out of or related to the Agreement, whether arising in tort, contract, or otherwise, without the written consent of the other party. These conditions and the entire Agreement are binding on the heirs, successors, and assigns of the parties hereto.

12. NO THIRD PARTY BENEFICIARIES

This Agreement gives no rights or benefits to anyone other than the CONTRACTOR and the CITY.

13. JURISDICTION

The laws of the State of Delaware shall govern the validity of this Agreement, its interpretation and performance, and any other claims related to it. In the event of any litigation arising under or construing this Agreement, venue shall lie only in Kent County, Delaware.

14. TERM AND TERMINATION

All services to be rendered by the CONTRACTOR within the Scope of Work within the Invitation to Bidders section of the **Invitation to Bid** shall be completed within three hundred sixty (360) calendar days from the date of the Notice to Proceed. All or part of this Agreement may be terminated by the CITY for its convenience on thirty (30) days written notice to the CONTRACTOR. In such event, the CONTRACTOR will be entitled to compensation for services competently performed up to the date of termination. In the event of termination not the fault of the CONTRACTOR, the CONTRACTOR shall be compensated for with Reimbursable Expenses then due and all Termination Expenses.

15. CONTACT PERSON

The primary contact person under this Agreement for the CONTRACTOR shall be

Name: _____, Phone No.: _____,
_____.

Address: _____ . The primary contact person under this Agreement for the CITY shall be Paul Thompson, Public Works Department.

16. APPROVAL OF SERVICE PERSONNEL

The CITY reserves the right to approve the contact person and the persons actually performing the services on behalf of the CONTRACTOR pursuant to this Agreement. If the CITY, in its sole discretion, is dissatisfied with the contact person or the person or persons actually performing the services on behalf of the CONTRACTOR pursuant to this Agreement, the CITY may require the CONTRACTOR assign a different person or persons be designated to be the contact person or to perform the services hereunder.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement on the respective dates under each signature.

(CONTRACTOR)

CITY OF DOVER

By: _____

By: Sharon J. Duca, P.E.

Title: _____

Title: Public Works Director/City Engineer

Signature: _____

Signature: _____

Date: _____

Date: _____

END OF SECTION A

NOTICE OF AWARD

TO: _____

PROJECT Description: Water Utility Construction for the **Water Treatment Plant Process Improvements Project Bid No.: 18-0014PW.**

The OWNER has considered the BID submitted by you for the above described WORK in response to its Invitation to Bidders and Information for Bidders.

You are hereby notified that your base BID has been accepted for the amount of:

(\$_____).

You are required by the Information for Bidders to execute the Agreement and furnish the required CONTRACTOR'S Performance BOND, Payment BOND and certificates of insurance within ten (10) calendar days from the date of this Notice to you.

If you fail to execute said Agreement and to furnish said BONDS within ten (10) days from the date of this Notice, said OWNER will be entitled to consider all your rights arising out of the OWNER'S acceptance of you BID as abandoned and as a forfeiture of your BID BOND. The OWNER will be entitled to such other rights as may be granted by law.

You are required to return an acknowledged copy of this NOTICE OF AWARD to the OWNER.

Dated this _____ day of _____ 201__.

The City of Dover, Owner

Signature:_____

Printed:_____

Title:_____

ACCEPTANCE OF NOTICE

Receipt of the above NOTICE OF AWARD is hereby acknowledged

Firm Name:_____

this the _____ day of _____, 2015

Signature:_____ Printed:_____

Title:_____

END OF SECTION NOA

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NOTICE TO PROCEED

TO: _____

Date: _____

Project: **Water Treatment Plant Process
Improvements, Bid No. 18-0014PW**

You are hereby notified to commence WORK in accordance with the Agreement dated _____
_____, 201_ on or before _____, 201_ and you are to complete the WORK
within ____ consecutive calendar days thereafter. The date of completion of all work is therefore
anticipated by _____, 201_.

The City of Dover
Owner

By: _____

Title: _____

ACCEPTANCE OF NOTICE

Receipt of the above NOTICE TO PROCEED is hereby acknowledged

by _____

this the _____ day of _____, 201_

By: _____ Title: _____

Employer Identification Number: _____

END OF SECTION NTP

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PERFORMANCE BOND

KNOWN ALL PERSONS BY THESE PRESENTS: That

(Name of Contractor)

(Address of Contractor)

a _____ hereinafter
(Corporation, Partnership or Individual)

called Principal, and _____
(Name of Surety)

(Address of Surety)

hereinafter call Surety, are held and firmly bound unto the City of Dover, 15 Loockerman Plaza, Dover, Delaware 19901 hereinafter called OWNER, in the total aggregate penal sum of _____

(\$ _____) in lawful money of the United States, for the payment of which sum well and truly to be make, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION is such that whereas, the Principal entered into a certain contract with the OWNER, dated the _____ day of _____, 201__, a copy of which is hereto attached and made a part hereof for the construction of: **Water Treatment Plant Process Improvements, Bid No.: 18-0014PW.**

NOW THEREFORE, if the Principal shall well, truly and faithfully perform its duties, all the undertakings, covenants, terms, conditions and agreements of said contract during the original term thereof, and any extensions thereof which may be granted by the OWNER, with or without notice to the SURETY and during the one year guaranty period and if the PRINCIPAL shall satisfy all claims and demands incurred under such contract, and shall fully indemnify and save harmless the OWNER from all costs and damages which it may suffer by reason of failure to do so, and shall reimburse and repay the OWNER all outlay and expense which the OWNER may incur in making good any default, the this obligation shall be void, otherwise to remain in full force and effect.

PROVIDED, FURTHER, that the said SURETY, for value received hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the contract or to WORK to be performed thereunder of the SPECIFICATIONS accompanying the same shall in any way affect its obligation on this BOND, and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the contract or to the WORK or to the SPECIFICATIONS.

PROVIDED, FURTHER, that it is expressly agreed that the BOND shall be deemed amended automatically and immediately, without formal and separate amendments hereto, upon amendment to the Contract not increasing the contract price more that 20 percent, so as to bind the PRINCIPAL and SURETY to the full and faithful performance of the CONTRACT as so amended. The term

“Amendment”, wherever used in this BOND, and whether referring to this BOND, the Contract or the Loan Documents shall include any alteration, addition, extension, or modification of any character whatsoever.

PROVIDED, FURTHER, that no final settlement between the OWNER and the PRINCIPAL shall abridge the right of the other beneficiary hereunder, whose claim may be unsatisfied. The OWNER is the only beneficiary hereunder.

IN WITNESS WHEREOF, this instrument is executed in _____ counterparts, each one of which shall be deemed an original, this the _____ day of _____, 201__.

ATTEST:

(SEAL)

_____ Secretary	_____ Principal
_____ Witness as to Principal	BY: _____ (s)
_____ Address	_____ Address
_____	_____
_____	_____

ATTEST:

(SEAL)

_____ Secretary	_____ Surety
_____ Witness as to Surety	BY: _____ (s)
_____ Address	_____ Attorney-in-Fact
_____	_____ Address
_____	_____

NOTES:

Date of BOND must not be prior to date of Contract.

IF CONTRACTOR is partnership, all partners should execute BOND.

IMPORTANT: Surety companies executing BONDS must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the State where the Project is located.

END OF SECTION PERB

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MAINTENANCE BOND

KNOWN ALL PERSONS BY THESE PRESENTS: That

_____ (Name of Contractor)

_____ (Address of Contractor)

a _____ hereinafter called
(Corporation, Partnership or Individual)

Principal, and _____ (Name of Surety)

_____ (Address of Surety)

hereinafter call Surety, are held and firmly bound unto the City of Dover, 15 Loockerman Plaza, Dover, Delaware 19901 hereinafter called OWNER, in the total aggregate penal sum of _____ Dollars, (\$ _____) in lawful

money of the United States, for the payment of which sum, well and truly to be make, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION is such that,

WHEREAS: The Principal entered into a certain contract with the OWNER, dated the _____ day of _____, 20__ and

WHEREAS: the Contract provides for the construction of: _____

which Contract is by reference incorporated herein, and made a part hereof, and is referred to as the Contract.

WHEREAS: said Contract provides that the Principal shall furnish a maintenance bond, and

WHEREAS: said Contract has been substantially completed, and a Certificate of Substantial Completion was issued on _____.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the Principal shall remedy any defects due to faulty materials or workmanship, and pay for any damages to other work resulting therefrom, which shall appear within a period of _____ year(s) from the date

of the Certificate of Substantial Completion as stated herein, then this obligation to be void; otherwise to remain in full force and effect.

PROVIDED, HOWEVER, that the OWNER shall give Principal and Surety notice of defects with reasonable promptness.

SIGNED and sealed this the _____ day of _____, 20__.

ATTEST:

(SEAL)

Secretary

Witness as to Principal

Address

Principal
BY: _____ (s)

Address

ATTEST:

(SEAL)

Secretary

Witness as to Surety

Address

Surety
BY: _____ (s)

Attorney-in-Fact

Address

NOTES:

Date of BOND must not be prior to date of Contract.
IF CONTRACTOR is partnership, all partners should execute BOND.

IMPORTANT: Surety companies executing BONDS must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the State where the Project is located.

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SECTION 00720

GENERAL CONDITIONS

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Wherever in these General Conditions or in other contract documents the following terms or abbreviations are used, and/or unless otherwise defined, the meaning shall be as follows:

1.01 ORGANIZATIONAL DEFINITIONS

- A. Administration: *Administration* shall mean the Mayor and Council Members of the City of Dover and/or the City Manager.
- B. Administrator: *Administrator* shall mean the City Manager of the City of Dover.
- C. Engineer: *Engineer* shall mean the City of Dover's consultant engineer.
- D. City: *City* shall mean the City of Dover whose administrative offices are located at, City of Dover City Clerk's Office, City Hall, 15 Lookerman Plaza, Dover, Delaware 19901.
- E. Owner: *Owner* shall mean the City of Dover, Kent County, Delaware.
- F. Reservation of rights: The City of Dover reserves the right to define any organizational term(s) used in the context of these general conditions and contract documents.

1.02 ABBREVIATIONS

AAN	American Association of Nurserymen
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
AWS	American Welding Society
AWPA	American Wood Preservers Association
AGC	Associated General Contractors of America
BOCA	Building Officials Conference of America
CRSI	Concrete Reinforcing Steel Institute
DELDOT	Delaware Department of Transportation
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration, U.S. Department of Transportation
FSS	Federal Specifications and Standards, General Services Administration
IES	Illuminating Engineers Society
MBMA	Metal Building Manufacturers' Association
MUTCD	Manual on Uniform Traffic Control Devices
NBFU	National Board of Fire Underwriters
NBS	National Bureau of Standards
NEC	National Electric Code
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration

RLMI	Reflector and Lamp Manufacturers' Institute
SAWP	Society of American Wood Preservers
ULI	Underwriters Laboratories, Inc.

1.03 DEFINITIONS

Agreement: The written instrument, executed by Owner and Contractor, that sets forth the Contract Price and Contract Times, identifies the parties and the Engineer, and designates the specific items that are Contract Documents.

Bid: A statement of price, terms of sale, and description of the supplies, services, or construction offered by a vendor to the City of Dover. The response may include but is not limited to a bidder's price and terms for the proposed contract, and description of technical expertise, work experience and other information as requested in the solicitation.

Bid Bond: The security, designated in the Bid, to be furnished by the bidder as a guaranty of good faith to enter into a contract with the City, if the work of constructing the improvement is awarded to him.

Bid Form: The approved form on which the City of Dover requires bids to be set forth and submitted.

Bid Guaranty: See Bid Bond.

Bid Price: Total Bid amount.

Bidder: A person formally submitting a bid for the work contemplated, acting directly or through a duly authorized representative.

Business: A corporation, partnership, individual, sole proprietorship, joint venture, or any other legal entity through which commercial activity is conducted.

Calendar Day: Every day shown on the calendar, Saturdays, Sundays, and holidays included.

Change Order: A written order signed by the responsible person assigned by the City of Dover, directing a Contractor to make changes to the contract documents.

City: City of Dover.

Construction: The process of building, adding, altering, converting, relocating, renovating, replacing, or restoring of real property in which the City has an interest.

Contingent Item: Any item listed in the contract documents and included in the bid for the purpose of obtaining a contract price. Such bid constitutes tender of an exercisable option to incorporate such items into the work in accordance with stated terms at bid prices.

Contract: An agreement entered into by the City of Dover for the procurement of supplies, services, construction, or any other item.

Contract does not include:

- Collective bargaining agreements with employee organizations; or
- Medical, Medicare, Judicare, or similar reimbursement contracts for which user eligibility and cost are set by law or regulation.

Contract Documents: The written agreement executed between the City of Dover and the successful bidder, covering the performance of the work and furnishing of labor, equipment and materials, by which the Contractor is bound to perform the work and furnish the labor, equipment and materials, and by which the City is obligated to compensate him therefore at the mutually established and accepted rate of price. The Contract shall include the Invitation to Bidders, Instructions to Bidders, Notice of Award, Notice to Proceed, Information for Bidders, Contract Forms (Agreement) and Bonds, General Conditions, Specifications, Special Conditions, also any written Change Orders and Supplemental Agreements that are required to complete the construction of the work in an acceptable manner, including authorized extension thereof.

Contract Drawings: The official drawings issued by the City of Dover as part of the contract documents, including those incorporated in the contract documents by reference. The Drawings referred to in the Contract Documents are entitled:

Water Treatment Plant Process Improvements
City of Dover, Kent County, Delaware

These drawings consist of the drawings included in the list of Drawings on the cover sheet.

Contract Item (Pay Item): An item of work specifically described and for which a price, either unit or lump sum, is provided. It includes the performance of all work and the furnishing of all labor, equipment, and materials, described herein or described in any Supplemental Specifications or Special Provisions.

Contract Modification: Any written alteration in the specifications, delivery point, date of delivery, contract period, price, quantity, or other provision of any existing contract, whether accomplished in accordance with a contract provision, or by mutual action of the parties to the contract. It includes change orders, extra work orders, supplemental agreements, contract amendments reinstatements, or options/renewals.

Contractor: The person or firm having a contract agreement with the City of Dover. A contractor does not include employees with labor contracts (collective bargaining agreements).

Contract Time or Completion Date: The number of working or calendar days shown in the contract indicating the time allowed for the completion of the work contemplated in the contract. In case a calendar date of completion is shown in the contract, in lieu of the number of working or calendar days, such work shall be completed by that date.

Day: Calendar day unless otherwise designated.

Easement: A grant of right of use of the property of an owner for a certain purpose at the will of the grantee.

Final Acceptance: The date as certified by the City when the construction of the project is complete and tested, all punch list items have been completed to the satisfaction of the City, and provisions of the public works or other agreements have been complied with.

Highway Standards: The official Book of Standards for Highway and Incidental Structures, edited by the Delaware Department of Transportation (DelDOT), with the latest incorporated revisions issued on or before the date of advertisement of the contract.

Information for Bidders: Any document, whether attached, or incorporated by reference, used for soliciting bids under procurement by competitive sealed bidding and small procurement procedures including requests for quotations.

Invitation to Bidders (ITB): Any document, whether attached, or incorporated by reference, used for soliciting bids under procurement by competitive sealed bidding and small procurement procedures including requests for quotations. The ITB includes the advertisement for Bids for all required work or materials. Such advertisement will indicate the location and magnitude of the work to be done or the character and quantity of the material to be furnished and the time and place of the opening of bids.

Laboratory: The testing laboratory which may be designated by the City of Dover.

Maintenance Bond: Security guaranteeing repairs to project defects appearing during guarantee period.

Materials: Any substances specified for use in the construction of the project and its appurtenances.

Notice of Award: The decision by the City of Dover to appoint or present a purchase agreement or contract to a vendor.

Notice to Proceed: A written notice to the Contractor of the date on or before which he shall begin the prosecution of the work to be done under the contract.

Payment Bond: A guarantee that Contractor will pay in full all bills and accounts for materials and labor used in the work, as provided by law.

Performance Bond: Security guaranteeing complete performance of the contract.

Person: Any individual, business, union, committee, club, or other organization.

Plans: See definition of "Contract Drawings".

Proposal: The response by a bidder to a solicitation of the City for construction. As used herein the word "proposal" means "bid."

Responsible Bidder: A person who has the capability in all respects to perform fully the contract requirements, and the integrity and reliability which will assure good faith performance.

Responsive Bid: A bid submitted in response to an Invitation for Bids that conforms in all material respects to the requirements contained in the Invitation for Bids.

Specifications: A written description of functional characteristics, or the nature of a construction item to be procured. It may include a statement of any of the user's requirements and may provide for inspection, testing, or preparation of a construction item before procurement. The definitions, descriptions, directions, provisions and requirements, contained herein, and all written supplements thereto, made or to be made, pertaining to the contract, and the material, equipment, and workmanship to be furnished under the contract.

Standard Specifications: A book of specifications intended to general application and repetitive use.

State: The State of Delaware acting through its authorized representative.

Subcontractor: Any person undertaking the construction of a part of the work under the terms of the contract, by virtue of an agreement with the Contractor, who prior to such undertaking, receives the (consent of the surety and the) approval of the City of Dover.

Superintendent: The executive representative of the Contractor authorized to receive and execute instructions from the City of Dover, who shall supervise and direct the construction.

Substantial Completion: That date as certified by ENGINEER when the construction of the PROJECT or a specified part thereof is sufficiently completed in accordance with the CONTRACT DOCUMENTS, so that the PROJECT or specified part can be utilized for the purposes for which it is intended.

Supplemental Agreement: Any contract modification which is accomplished by the mutual action of the parties.

Supplemental Specifications: Additions and revisions to the Standard Specifications. Generally include new or improved procedures, construction items or materials developed subsequent to the publication of Standard Specifications.

Surety: The corporate body bound with and for the Contractor, for the full and complete performance of the contract, and for the payment of all debts pertaining to the work. When applying to the Bid Bond, it refers to the corporate body which engages to be responsible in the execution by the bidder of a satisfactory contract.

Work: Work shall be understood to mean the furnishing of all labor, materials, equipment, and other incidentals necessary to the successful completion of the project and the carrying out of all the duties and obligations imposed by the contract.

1.04 CONTRACTOR'S AND SUBCONTRACTOR'S INSURANCE

- A. The Contractor shall not commence work under this contract until he has obtained all the insurance required under this paragraph and such insurance has been approved by the Owner, nor shall the Contractor allow any Subcontractor to commence work on his subcontract until the insurance required of the Subcontractor has been so obtained and approved.
- B. Compensation and Employer's Liability Insurance
 - 1. The Contractor shall take out and maintain during the life of the contract the statutory Workmen's Compensation and Employer's Liability Insurance for all his employees to be engaged in work on the project under the contract and, in case any such work is sublet, the Contractor should require the subcontractor similarly to provide Workmen's Compensation and Employer's Liability Insurance for all the latter's employees to be engaged in such work.
- C. Bodily Injury Liability and Property Damage Liability Insurance
 - 1. The Contractor shall take out and maintain during the life of the contract Bodily Injury Liability and Property Damage Liability Insurance to protect him and any Subcontractor performing work covered by the contract from claims for damages for personal injury, including accidental death, as operations under the contract, whether such operations be by himself or by a Subcontractor, or by anyone directly or indirectly employed by either of them, and the amount of such insurance should not be less than:
 - 2. Bodily Injury Liability Insurance, in an amount not less than one million dollars (\$1,000,000) for injuries, including wrongful death to any one person, and subject to the same limit for each person in an amount not less than two million dollars (\$2,000,000) on account of one accident.
 - 3. Property Damage Insurance, in an amount not less than two million dollars (\$2,000,000) for damages on account of any and all accidents.
- D. Automobile Bodily Injury Liability Insurance
 - 1. Automobile Bodily Injury Liability Insurance in an amount not less than five hundred thousand dollars (\$500,000) for bodily injuries per person, one million dollars (\$1,000,000) for bodily injuries per occurrence, and one million dollars (\$1,000,000) for property damage.
- E. Proof of Carriage of Insurance
 - 1. The Contractor shall furnish the Owner with Certificates showing the type, amount, class of operations, effective dates, and date of expiration of policies. Such certificates shall contain substantially the following statement. "The insurance covered by this certification shall not be canceled or materially altered, except after thirty (30) days written notice has been received by the owner."

1.05 PERMITS, FEES AND NOTICES

- A. The Contractor shall pay taxes, royalties, and fees, and secure licenses and permits that are required, during the time of the contract, by local, county, state and federal laws, ordinances, rules, codes and regulations for the legal performance of the contract.
- B. The contractor shall perform the work in accordance with notices issued by public authorities having jurisdiction over the work, including but not limited to Delaware Department of Transportation, and Delaware Board of Public Health.
- C. If the Contractor performs work, knowingly or ignorantly, contrary to requirements of local, county, state and federal laws, ordinances, rules, codes and regulations, he shall assume full responsibility therefore and shall bear all costs of suits, actions and damages resulting from his illegal work performed.

1.06 INDEMNIFICATION OF THE OWNER

- A. The Contractor shall indemnify and hold harmless the Owner and the Engineer, and all who represent them, from and against claims, damages, losses and expenses arising out of the Contractor's performance of the work, provided such claim damage, loss and expense are attributable to:
 - 1. Bodily injury, sickness, disease or death, or to injury to tangible property, including the loss of use resulting therefrom, and
 - 2. Negligence of the Contractor or his subcontractors and others directly related to the project or both.
- B. Monies due the Contractor for performance of the contract may be retained by the Owner, as may be considered by the Engineer as necessary, until such suits and claims for damages shall have been settled and evidence of such settlement furnished by the engineer.

1.07 PATENTS

- A. Whenever articles, materials, means, appliances, processes, compositions, combinations and things indicated by these specifications are covered by letters patent, the successful Bidder shall secure, before using or employing such articles, materials, means, appliances, processes, compositions, combinations or things, the assent, in writing of the Owner or licensee of such letters patent and file the assent with the Engineer.
- B. The said assent is to cover not only the use, employment and incorporation of said articles, materials, means, appliances, processes, compositions, combinations or things in the construction and completion of the work, but also the permanent use of said articles, materials, means, appliances, processes, compositions, combination or things, thereafter by or on behalf of the Owner in the operation and maintenance of the project for the purpose for which it is intended or adapted.
- C. The Contractor shall be responsible for claims made against the Owner and his agents and employees for actual or alleged infringement or patents by the use of the work, and

shall save harmless and indemnify the Owner and his agents and employees from all costs, expenses, and damages, including solicitors' and attorney's fees, which the Owner may be obligated to pay by reason of any actual or alleged infringement of patents used in the construction, completion, maintenance, or operation of the works and project herein specified.

- D. If the Contractor uses any patented or copyrighted articles, materials, means appliances, processes, compositions, combinations or things he shall provide for such use by suitable agreement with the Owner of such patented or copyrighted articles, materials, means appliances, processes, compositions, combinations or thing. It is mutually agreed and understood that without exception, the Contract prices shall include all royalties or costs arising from the use design, device or materials in any way involved in the work.

1.08 SCOPE OF WORK

- A. The work to be done under these specifications is to cover the completed work shown on the plans or called for in the specifications and other contract documents. The Contractor shall furnish all implements, machinery, tools, equipment, material and labor necessary to the performance of the work and shall furnish and do everything necessary to make the work perfect, complete, neat, and finished, and the Contractor shall leave all the work to be done under this Contract in this condition at the time the work is finally inspected.

1.09 DRAWINGS TO BE FOLLOWED

- A. The approved plans, profiles, details and cross sections on file in the office of the Engineer will show the location, details and dimensions of the work contemplated, which shall be performed in strict accordance therewith and in accordance with the specifications. There shall be no deviation from the drawings and specifications on account of the exigencies of construction, unless approved and authorized in writing by the Engineer.

1.10 INTERPRETATION OF DRAWINGS

- A. On all drawings, the figured dimensions shall govern in the case of discrepancy between the scales and figures. The Contractor shall take no advantage of any error or omission in the drawings or of any discrepancy between the drawings and specifications, and the Engineer will make such corrections and interpretations as may be deemed necessary for the fulfillment of the intent of the specifications, and of the drawings as construed by him. In all cases of doubt as to the true meaning of the specifications and drawings, the decision of the Engineer will be final and conclusive.

1.11 ALTERATION OF DRAWINGS AND CHARACTER OF WORK

- A. The Engineer reserves the right to make such alterations in the drawings and in the character of the work necessary or desirable, or both, from time to time to complete the construction of the work, provided such alterations do not change materially the original drawings and specifications; and such alterations shall not be considered as a

waiver of conditions of the contract, nor shall they invalidate any of the provisions thereof. Should such alterations in the drawings or in the character of work, or both, cause increased or decreased cost to the Contractor, a fair and equitable sum therefore, to be agreed upon in writing by the Contractor and Engineer before such work is begun, shall be added or deducted from the contract price. No allowance will be made for anticipated profits on the work omitted.

1.12 AS-BUILT DRAWINGS

- A. During the process of the work, the Contractor shall keep a careful record at the jobsite of all changes and deviations from the layouts shown on the Contract Drawings immediately. The As-Built Drawing shall indicate, in addition to any changes or deviations, the actual location referenced from at least two (2) permanently fixed surface structures of all subsurface utilities or work including valves, cleanouts, manholes, etc. installed by him. These drawings will be made available to the Engineer for inspection or checking at any time during the construction period. At the time of Conditional Acceptance of the Work the Contract Drawings with all the aforementioned as-built information clearly recorded thereon in ink.
- B. The Contractor shall keep one copy of all Contract Documents, Specifications, Drawings, Errata, Addenda, Change Orders, and Shop Drawings at the site in good order and annotated to show all changes made during the construction process. These shall be available to the Engineer for inspection during the contract period.
- C. No Separate payment will be made to the Contractor for As-Built Drawings as all costs in connection therewith shall be deemed to be included in the lump sum prices of the bid. If the Contractor fails to maintain up to date As-Built Drawings and records as herein required, the Engineer reserves the right to withhold monthly payments in part or in full until such time as the Contractor has compiled in all respects to these requirements.
- D. Should the Contractor fail to make needed repairs and replacements promptly during the maintenance and repair period, the Owners shall be empowered to make any repairs or replacements and the costs of the required repairs or replacements shall be the financial responsibility of the Contractor.

1.13 EXTRA WORK

- A. The Contractor shall perform extra work, for which there is no quantity and price included in the contract, whenever to complete fully the work contemplated it is deemed necessary or desirable, by written authority of the Engineer, and such work shall be done in accordance with the specifications therefore or in the best workmanlike manner as directed. This extra work will be paid for at a unit price or lump sum to be agreed upon previously, in writing, by the Contractor and the Engineer, or where this method of payment is impracticable, the Engineer may order the Contractor to do such work on a "Force Account" basis.

1.14 FORCE ACCOUNT WORK

- A. Cost of extra work done on a "Force Account" basis will be paid in the following manner:

1. For labor and foremen in direct charge of the specific operation, the Contractor shall receive the rates of wages paid during this contract as substantiated by certified payroll slips, for each and every hour that said labor and foreman are actually engaged in such work, to which shall be added an amount equal to fifteen percentum (15%) of the sum thereof.
 2. The Contractor shall receive the actual cost of materials utilized, as shown by original receipted bills, to which sum shall be added an amount equal to fifteen percentum (15%) of the sum thereof.
 3. For machine-power tools and equipment, and for hauling equipment, including fuel and lubricants, which may be deemed necessary and desirable to use, the Owner shall allow the Contractor a reasonable rental price to be accepted in writing before such work is begun, for each and every hour that said tools and equipment are in use on such work, and to which sum no percentage shall be added.
 4. For all work performed by subcontractors, the Contractor shall receive the rate billed to him by the subcontractor for each and every hour that said subcontractor is actually engaged in such work to which shall be added an amount equal to ten percentum (10%) of the sum.
- B. The compensation as herein provided shall be received by the Contractor as payment in full for extra work done on a "force account" basis, and shall include superintendence, use of tools and equipment for which no rental is allowed, and profit. The Contractor's representative and the Resident Project Representative (R.P.R.) shall compare records of extra work on a "force account" basis at the end of each day. Copies of these records shall be made in duplicate, upon the Engineer's "force account forms" and signed by both the R.P.R. and the Contractor's representative, one copy being forwarded respectively to the engineer and to the Contractor. Claims for extra work performed on a "force account" basis shall be submitted to the Engineer, in triplicate, on certified forms properly executed, by the Contractor. Statements shall also include the value of all material used in such work, and said statements shall be filed not later than the fifteenth (15th) day of the month following that in which the work was actually performed, and shall include all charges which can be verified.
- C. For extra work, as defined in this paragraph, the Contractor will be reimbursed for his expenditures for Workmen's Compensation Insurance, Public Liability Insurance, Social Security taxes and Unemployment Compensation covering the workers actually engaged upon such extra work. No percentage will be added to such payments, but the Contractor shall receive only the actual amount on money expended for such Workmen's Compensation Insurance, Public Liability Insurance, Social Security taxes and Unemployment Compensation. Such payments shall be based upon the prevailing standard insurance rates supported by receipted vouchers from the insurance vendors and upon the actual amount of taxes paid for Social Security and Unemployment Compensation as evidenced by proper documents furnished by the Contractor.

1.15 UNAUTHORIZED WORK

- A. Work performed without Engineer's approval of lines and grades, work performed beyond the lines and grades shown on the drawings or as given, except as herein provided, and extra work performed without written authority, will be considered as unauthorized and at the expense of the Contractor. Such work will not be measured by the Engineer, nor will payment be made by the Owner. Work so performed may be ordered, by the Engineer removed and replaced at the Contractor's expense.

1.16 EXECUTION OF WORK

- A. The Contractor shall begin the work to be performed under the contract at the time stated in the Notice to Proceed, provided by the Owner to the Contractor. The place where the work is to be started will be stated either in this notice to proceed or will be designated on the ground. The work shall be executed from as many different points, in such part or parts and at such times as may be directed, and shall be conducted in such a manner and with sufficient materials, equipment and labor as is considered necessary to insure its completion with the time set forth in the contract.
- B. If the work should be discontinued because of unforeseen events, the Contractor shall immediately notify the Engineer and City. When the Contractor shall discontinue the work because of a planned stoppage, the stoppage shall not take place until the Engineer has authorized such stoppage; and work shall not be resumed until Contractor notifies Engineer and City 24 hours in advance of starting work again.

1.17 COOPERATION OF CONTRACTOR AND REPRESENTATIVE

- A. The Contractor shall give the work his constant attention to facilitate the progress thereof and shall cooperate with the Engineer and Owner. The Contractor shall have at all times a competent and reliable representative on the work, authorized to receive orders and act for him.

1.18 EMPLOYEES AND EQUIPMENT

- A. Employees of the Contractor or persons connected with the Contractor shall be discharged upon request of the Engineer for any or all of the following reasons:
 - 1. Directing profanity or abusive language, or both, at the Resident Project Representative and other Owner's representatives.
 - 2. Interfering with Resident Project Representative and other Owner's representatives in performance of their work.
 - 3. Disobeying or evading, or both, instructions of the Resident Project Representative and other Owner's representatives.
 - 4. Careless or incompetency, or both.
 - 5. Being objectionable to the Owner.

6. Discharged employees shall not be rehired without consent of the Engineer.

B. Contractor shall furnish, and maintain in safe working condition, equipment necessary to properly perform the work in the scheduled time.

1.19 DRAWINGS AND SPECIFICATIONS FURNISHED TO CONTRACTOR

A. The Owner will furnish Contractor two (2) copies of the drawings and specifications; Contractor shall have one (1) set available at the job site during execution of work and including copies of all sets approved by any permitting, review, or regulatory authority. Additional copies of the drawings and specifications will be furnished to the Contractor upon receipt of payment of the amount stated in the Advertisement for each set.

1.20 LAWS TO BE OBSERVED

A. The Contractor shall observe and comply with federal, state, county, and local laws, ordinances, rules, regulations, decrees and orders that are in effect and applicable to the work during the time of construction; and he shall see that his subcontractors likewise meet this requirement. He shall indemnify, and hold harmless, the Owner and his representatives against claims and liabilities arising from Contractor and subcontractor violations of such laws, ordinances, rules, regulations, decrees, and orders whether such violations be by the Contractor or any Subcontractor, or an of their agents and/or employees.

1.21 SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION

A. In order to protect the lives and health of his employees under the contract, the Contractor shall comply with all pertinent provisions of the Contract Work Hours and Safety Standards Act, as amended, commonly known as the Construction Safety Act as pertains to health and safety standards; and shall maintain an accurate record of all cases of death, occupational disease, and injury requiring medical attention or causing loss of time from work, arising out of and in the course of employment on work under contract.

B. The Contractor alone shall be responsible for the safety, the adequacy of his work, appliances, and methods, and for any damage which may result from their failure or their improper construction, maintenance or operation. The Contractor will comply, within the prices bid and without extra cost to the Owner, with all safety regulations or determinations issued by any agency of the Federal government including OSHA, the State of Delaware and the Engineer.

1.22 SANITARY PROVISIONS

A. The Contractor shall provide and maintain in a neat and sanitary condition such sanitary conveniences and accommodations for the use of his employees as may be necessary to comply with the requirements and regulations of the Department of Health or of other bodies or tribunals having jurisdiction thereof. He shall commit no public nuisance.

1.23 PUBLIC CONVENIENCE AND SAFETY

- A. The Contractor shall conduct the work in a manner that will minimize obstruction to traffic in the area. The safety and convenience of the general public and of the residents and occupants of property along and adjacent to the work shall be provided in an adequate and satisfactory manner. Footways and portions of the highways and streams adjoining the work shall not be obstructed more than absolutely necessary. In no case shall any traveled thoroughfare be closed without permission of the Owner.
- B. Fire Hydrants on or adjacent to the work shall be kept accessible to fire apparatus at all times, and no obstructions shall be placed within 15 feet of a hydrant.
- C. Gutters and storm drain inlets shall be kept unobstructed at all times, unless the obstruction is sediment and erosion control.

1.24 BARRICADES, DANGER, WARNING, AND DETOUR SIGNS

- A. The Contractor shall provide, erect, and maintain all necessary barricades, suitable and sufficient lights, danger signals and signs, provide a sufficient number of watchmen and take all necessary precautions for the protection of the work and safety of the public. Highways closed to traffic shall be protected by effective barricades, on which shall be placed acceptable warning signs. The Contractor shall detour traffic and shall furnish and maintain all detour signs required to direct traffic over the entire route of the detour. Costs for maintaining traffic shall become incidental to the bid terms of this contract and will not be paid for directly. At all times, the Contractor shall use every precaution possible to warn pedestrians and the traveling public as to the construction in progress. All traffic safety devices shall be in accordance with the most recent Delaware Manual on Uniform Traffic Control Devices (MUTCD).

1.25 PRESERVATION AND RESTORATION OF PROPERTY, TREES, MONUMENTS, ETC.

- A. The Contractor shall not enter upon private property for any purpose without obtaining permission, and he shall be responsible for the preservation of all public and private property, trees, monuments, etc., along and adjacent to the work and shall use every precaution necessary to prevent damage and injury thereto. He shall use suitable precautions to prevent damage to pipes, conduits and underground structures, and shall protect carefully from disturbance or damage all land monuments and property marks until an authorized agent has witnessed or otherwise referenced their location and shall not remove them until directed, and the cost for replacement of the same shall be borne by the Contractor. Property marker replacement shall be by a surveyor licensed in the State of Delaware. The Contractor shall not willfully or maliciously injure or destroy trees or shrubs, and he shall not remove or cut them without proper authority. He shall be responsible for all damage or injury to the property of any character, during the prosecution of the work, resulting from any act, omission or misconduct in his manner or method of executing said work or due to the non-execution thereof on the part of the Contractor. He shall restore, at his own expense, such property to a condition similar or equal to that existing before such damage or injury, in an acceptable manner. In case of the failure on the part of the Contractor to restore such property, or make good such damage or injury, the Owner may, upon

forty-eight (48) hours notice, proceed to repair, rebuild or otherwise restore such property as may be deemed necessary, and the cost thereof will be deducted from the monies due or which may become due the Contractor under his contract.

1.26 CONTRACTOR'S RESPONSIBILITY FOR WORK

- A. Until the final acceptance of all work shall be indicated in writing by the Owner, the work shall be under the charge of and care of the Contractor. He shall take every precaution against destruction of, injury, or damage to the work or to any part thereof from any other cause whatsoever. The Contractor shall rebuild, repair, restore and make good, at his own expense, all deduction of, injuries, or damage to the work or any of the above causes before its final completion and acceptance shall be indicated in writing by the Owner.
- B. No inspection or supervision, no failure to inspect or supervise, nor the pressure of any employees of the Engineer during the execution of the work, and no approval or acceptance of any part of the work herein contracted for, or of the materials and equipment used therein, shall relieve the Contractor of any of his obligations to fulfill his contract, or shall prevent the rejection of said work, materials, and equipment in whole or in part, at any time thereafter should said work, materials or equipment be found by the Engineer to be defective or not in accordance with the requirements of these Contract Documents.

1.27 CERTIFICATIONS & SHOP DRAWINGS

- A. Contractor shall submit shop drawings, material certifications, samples and test reports to the Engineer,
- B. The Contractor shall submit to the Engineer for review:
 - 1. Six (6) copies of certifications for all materials to be incorporated in the work.
 - 2. Six (6) copies of certified working drawings for all fabricated or manufactured articles to be used in the work.
 - 3. Six (6) copies of layout drawings for installation and erection of the work.
 - 4. Such other certifications and/or drawings as may be from time to time required.
- C. All shop drawings shall be submitted to the Engineer through the Contractor. Direct submittals by subcontractors shall not be accepted. The Contractor shall review, sign each copy of a shop drawing noting review and approval prior to submittal. Drawings will not be considered unless they have been stamped approved by the Contractor.
- D. Drawings shall be to scale, shall be accurate and distinct, and shall give all dimensions required for the manufacturing and erection of the work, and shall also outline sectional views and details showing all working dimensions, kind of material to be used, and kind of machine work and finish to be applied.

- E. Three sets of drawings will be returned to the Contractor, approved if found correct, or else showing the changes required. Where major corrections are required, six sets shall be resubmitted until final approval is given. The Engineer will review one original submittal and one resubmittal for each item requiring shop drawings without charge to the Contractor by the Engineer according to the hourly rate in effect at that time.
- F. No item requiring submission of detailed drawings shall be manufactured prior to final approval of the drawings.
- G. The approval of shop drawings will be general, and will not relieve the Contractor of his responsibility to construct, manufacture and erect all parts of the structure and equipment, and to furnish materials and work as required by the Contract Documents. The approval of shop drawings shall not be construed as approving any variation from the contract drawings or specifications. The Engineer will not be responsible for errors on drawings furnished by the Contractor, even though drawings containing such errors are inadvertently approved.

1.28 USE OF A SECTION OF THE WORK

- A. Whenever, in the opinion of the Engineer, a portion of the work is acceptable condition for the Owner's use, it may be used for its intended purpose; and such use shall not imply final acceptance of that portion of the work, nor waive any provisions of these contract documents.

1.29 TEST AND SAMPLES OF MATERIALS

- A. Tests of materials shall be made at the Contractor's expense, by a certified testing laboratory, in accordance with the officially approved methods as described or designated. The Owner reserves the right to conduct verification testing at his own expense. The Contractor shall cooperate with and assist the Owner in conducting such testing and in taking samples and packing them for shipment to a laboratory.

1.30 STORAGE OF MATERIALS

- A. Materials shall be stored so as to insure the preservation of their quality and fitness for the work. When considered necessary, they shall be placed on wooden platforms or other hard clean surfaces, and not on the ground, and shall be placed under cover when directed. Stored materials shall be located so as to facilitate prompt inspection. Lawns, grass plots, or other private property shall not be used for storage purposes without written permission of the owner or lessee.

1.31 QUALITY OF MATERIALS AND WORKMANSHIP

- A. Materials and workmanship shall be of best possible quality and feasibility for the intended purpose, whether or not a brand name is specified. Materials shall be new and unused.
- B. Representative preliminary samples of materials may be requested by the Engineer for examination or testing, or both. Materials, for which samples are submitted to

Engineer, shall not be ordered by Contractor until Engineer furnishes written approval of said samples. Materials may be further inspected by the Engineer during preparation and construction of the work; and materials found to be substandard will be rejected.

- C. Contractor shall submit to Engineer samples of alternate materials that require laboratory testing. Such materials shall not be incorporated into the work until Engineer states, in writing, that materials meet requirements of the specifications.

1.32 EQUAL OR APPROVED EQUAL

- A. Where an article or material is specified by proprietary name, trade name, and/or manufacturer's name, with the addition of such expressions as "or equal", or "approved equal", it is to be understood that the article named, or the equal thereof, is intended subject to the approval of the Engineer as to the equality thereof, and it is distinctly understood:
 - 1. That the Engineer is to use his own judgment in determining from time to time whether or not any articles or thing proposed to be substituted is the equal of any article or thing so specified;
 - 2. That the decision of the Engineer on all such questions of equality shall be final; and
 - 3. That in the event of any adverse decision by the Engineer, no claim of any sort shall be made or allowed against the Owner or the Engineer.
- B. An Offer of an article or material by the Contractor for an article or material by the contractor for an article or material specified, will raise the presumption that it is for the purpose of saving money. If, in such case the articles or material is approved, the Owner shall be given credit as follows: the difference in the net cost to the Contractor of the article or material submitted and the price at which he could have obtained the lowest priced article or material specified. For convenience in checking the credit, if any, the Contractor shall submit these figures when the offer is made, and no article or materials will be considered without figures.

1.33 WATER SUPPLY

- A. The Contractor shall at his own cost provide such quantities of clean water as may be required for any and all purposes under the contract. He shall supply sufficient drinking water to all his employees.
- B. Water supply shall be obtained at the filling station located at 710 William Street, Dover, DE 19904. Water cannot be obtained through use of a fire hydrant. Connection to a fire hydrant is prohibited.

1.34 AUTHORITY OF ENGINEER

- A. The Engineer shall, in all cases, determine the amount or quantity, quality and acceptability of the work and materials for which payment is made under this contract. He shall decide on all questions in relation to said work and the performance thereof.

He shall, in all cases, decide on questions which arise relative to the fulfillment of the contract, to the contract and to the obligations of the Contract there under.

- B. To prevent disputes and litigations, the Engineer will be the referee in questions between the Contractor and the Owner concerning the contract. Engineer's determination, decision and/or estimate shall be final and conclusive upon the contractor and shall also be a condition precedent to the right of the Contractor to receive monies under the contract.

1.35 AUTHORITY AND DUTIES OF RESIDENT PROJECT REPRESENTATIVE

- A. Resident Project Representatives (R.P.R.'s) employed by the Owner or Engineer shall be authorized to observe all work done and materials furnished. Such observations may extend to all or any part of this work and to the preparation or manufacture of the materials to be used. An R.P.R. may be stationed on the work to report to the Engineer as to the progress of the work and the manner in which it is being performed; also to report whenever it appears that the materials furnished and work performed by the Contractor fail to fulfill the requirements of the specifications and contract. No inspection, or any failure to inspect, at any time or place, however, shall relieve the Contractor from his obligation to perform all the work strictly in accordance with the requirements of the specifications. The R.P.R. shall perform such other duties as are assigned to him. He shall not be authorized to revoke, alter, enlarge, relax or release any requirements of these specifications, nor to approve or accept any portion of work, nor to issue instruction contrary to the drawings and specifications. The R.P.R. shall in no case act as foreman or perform other duties for the Contractor, nor interfere with the management of the work by the latter.

1.36 INSPECTION OF MATERIALS AND WORK

- A. The Contractor shall furnish the Engineer with every reasonable facility for ascertaining whether or not the work as performed is in accordance with the requirements and intent of the specifications and contract. If the Engineer requests it, the Contractor, at any time before acceptance of the work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications without additional compensation. Should the work thus exposed or examined prove unacceptable, the removing, replacing and/or making good the parts removed shall be at the Contractor's expense.

1.37 DEFECTIVE MATERIALS AND WORK

- A. All materials not conforming to the requirements of these specifications shall be considered defective and all such materials whether in place or not, shall be rejected and shall be removed immediately from the work unless otherwise permitted. No materials which have been rejected, the defects of which have been corrected or removed, shall be used until approval has been given. All work which has been rejected or condemned shall be remedied, or if necessary, removed and replaced in an acceptable manner by the Contractor at his/her own expense.

1.38 FAILURE TO REMOVE AND RENEW DEFECTIVE MATERIALS AND WORK

- A. Should the Contractor fail or refuse to remove and renew defective materials used or work performed previously or to make any necessary repairs in an acceptable manner, and in accordance with the requirements of these specifications, within the time indicated in writing, the Engineer shall have the authority to cause the unacceptable or defective materials or work to be removed and renewed or such repairs to be made at the Contractor's expense. Expense incurred by the Owner in making these removals, renewals, or repairs, which the Contractor has failed or refused to make, shall be paid out on any monies due or which may become due the Contractor, or may be charged against the "Performance Bond" deposited. Continued failure or refusal on the part of the Contractor to make any or necessary repairs, removals and renewals promptly fully and in an acceptable manner, shall be sufficient cause for the Owner to declare the contract forfeited, in which case the Owner, at his option, may purchase tools, materials and equipment and employ labor, as may be required to perform the work. All costs and expenses incurred thereby shall be charged against the "Performance Bond" deposited. The performance of work by the Owner and/or others as specified shall not relieve the Contractor in any way from his responsibilities under this contract.

1.39 WORKING TIME

- A. The Contractor will not be permitted to work on Saturday, Sunday or holidays unless otherwise authorized by the Owner in writing.
- B. In case of an emergency, which may require that work be done on Saturdays, Sundays, Holidays, the Contractor shall request permission of the Owner to do so. If, in the opinion of the Engineer, the emergency is bonafide, he will grant permission of the Contractor to work such hours as may be necessary. Also, if in the opinion of the Engineer a bonafide emergency exists, he may direct the Contractor to work such hours as may be necessary whether or not the Contractor requests permission to do so.
- C. The Contractor will be allowed to work eight (8) hours per day, Monday through Friday, except for holidays. All work specified under these Contract Documents shall be performed between the hours of 7:30 A.M. and 3:30 P.M. An alternate continuous daily work period may be satisfactory; however, it is subject to approval by the City.
- D. The Contractor shall pay the Owner for all costs incurred for inspection services required for work permitted during holidays, weekends, outside of city business hours, or in excess of eight (8) work hours per day.

1.40 TEMPORARY SUSPENSION OF WORK

- A. The engineer shall have the authority to suspend work, wholly or in part, for such period or periods as he may deem necessary, due to unsuitable weather, or such other conditions as are considered unfavorable for the suitable execution of the work, or for such time as is necessarily due to the failure on the part of the Contractor to carry out orders given or perform any or all provisions of the contract. If it should become necessary to stop work for an indefinite period, the Contractor shall store all materials in such a manner that they will not obstruct or impede the traveling public

unnecessarily nor become damaged in any way, and he shall take every precaution to prevent destruction, damage or deterioration of the work performed, provide suitable drainage by opening ditches, shoulder drains, etc., and erect temporary structures where necessary. The Contractor shall not suspend the work without authorization. Neither the failure of the Engineer to notify the Contractor to suspend the work on account of bad weather or other unfavorable conditions, nor permission by the Engineer to continue work during bad weather or other unfavorable conditions, shall be a cause for the acceptance of any work which does not comply in every respect with the contract and specifications.

1.41 ANNULMENT OF CONTRACT

- A. Contract may be annulled if Contractor defaults in any or all of the following ways:
1. Failure to begin work at time specified
 2. Failure to perform the work with sufficient number of workers.
 3. Failure to provide sufficient materials to insure prompt completion of the work, except where extension of time is granted.
 4. Failure to perform the work suitably.
 5. Failure to remove materials of rejected work.
 6. Failure to correct rejected work
 7. Failure to execute the work in manner acceptable to Engineer.
 8. Becoming bankrupt or insolvent, or both.
 9. Allowing a final judgment against him unsatisfied for 48 hours
 10. Making an assignment for the benefit of creditors.
 11. Failure to pay subcontractors for labor.
 12. Failure to pay for materials supplies
 13. Persistently disregarding laws, rules, ordinances, regulations, and codes applicable to the work.
 14. Disregarding Engineer's instructions.
 15. Failure to comply, within three (3) days after Contractor's receipt (by certified mail, with return receipt requested) of Engineer's orders to properly execute the work.
 16. Lapse of Contractor's Insurance.

- B. Engineer may act to annul the contract, because of any or all of Contractor's defaults, in the following manner:
 - 1. Give written notice to Contractor and/or his surety of details of Contractor's default.
 - 2. Issue certificate to Owner describing Contractor's default.
- C. Owner, upon receipt of such certificate (preceding paragraph), has full power and authority to terminate Contractor's employment and to take possession of the premises; materials, appliances and equipment of the work on the premises. Certificate shall further empower Owner to enter into an agreement for completion of said contract according to the terms and provisions thereof, or to utilize other methods shall be deemed expedient for completion of the contract in accordance with the drawings and specifications.
- D. The owner shall have the right to take the following actions because of any or all of the defaults hereinbefore described:
 - 1. Withhold without paying interest, such sums of money due Contractor until Owner's claims have been protected.
 - 2. Deduct monies due the Contractor equal to amount required to pay Owner's expenses for Owner's completing the work of the contract.
 - 3. Pay the defaulted Contractor an amount equal to the difference between actual cost of Owner's completing the contract and the sum which would have been paid to Contractor had he not defaulted, if the cost to complete the work is less than amount owed the defaulted Contractor.
 - 4. Collect from the defaulted Contractor and/or surety an amount equal to the difference between actual cost of Owner's completing the contract and the sum which would have been paid to the Contractor had he not defaulted, if the cost to complete the work is more that the amount owed the defaulted contractor.

1.42 MEASUREMENT OF QUANTITIES

- A. All work completed under the contract shall be measured by the Engineer of the Resident Project Representative according to United States Standard Measures.
- B. In computing tonnage, certified freight weigh-bills or certified weight-slips will be utilized. Other quantities will be determined according to recognized engineering practices or as defined on drawings.

1.43 PAYMENT FOR MATERIALS WHEN PAYMENT IS NOT MADE BY CONTRACTOR

- A. When persons furnishing labor or material, or both submit notice of completion and conditional acceptance, Contractor shall furnish the Engineer evidence that payment has been made for such labor and material. If such evidence is not produced, amounts of claims may be retained from monies due the Contractor until claims are satisfied or until notices are withdrawn.

- B. The Owner or the Engineer may also, with the written consent of the Contractor, use monies retained or due the Contractor to pay labor and material costs for the work, provided claims have been filed in the office of the Engineer.

1.44 NO ESTOPPEL OR WAIVER OF LEGAL RIGHTS

- A. The Owner or the Engineer, shall not be precluded or estoppel by any measurement, estimate or certificate, made or given by him, or by any agent or employee of the Owner, under any provision or provisions of the contract, at any time, either before or after the completion and acceptance of the work and payment therefor pursuant to any measurement, estimate, or certificate, from showing the true and correct amount and character of the work performed and materials furnished by the Contractor or from showing at any time that the measurement, estimate, or certificate is untrue or incorrectly made in any particular, or that the work or materials or any part thereof do not conform in fact to specifications and contract, and the Engineer shall have the right to reject the whole or any part of the aforesaid work or materials, should the said measurement, estimate, certificate or payment be found or be known to be inconsistent with the terms of the contract, or otherwise be improperly given, and the Owner shall not be precluded and estopped, notwithstanding any such measurement, estimate, certificate and payment in accordance therewith from demanding and recovering from the Contractor and his Surety such damages as it may be sustained by reason for his failure to comply with the terms of the specifications and contract. Neither the acceptance by the Owner, or the Engineer, or any agent or employee of the Owner nor any certificate by the Owner for payment of money, nor any payment for, nor acceptance or use of the whole or any part of the work by the Owner, or the Engineer nor any extension of time, nor any possession taken by the Owner or its employees, shall operate as a waiver of any branch of the contract be held to be a waiver of any other subsequent breach.

1.45 SUBCONTRACTORS

- A. The Contractor shall give his personal attention to the faithful performance of the work, shall keep the same under his own control, and shall not assign the contract by power of attorney or otherwise, nor sublet the work or any part thereof, without the previous written consent of the Engineer. He shall state to the Engineer in writing the name of each subcontractor he intends employing, the portion of the work which he is to do or the materials which he is to furnish, his place of business and such other information as the Engineer may require, in order to know whether such subcontractors are reputable and reliable and able to perform the work or to furnish the materials as called for in the specifications. No subcontractor shall be engaged upon any branch of the work who is not thoroughly practical and reasonable and at the time of making this contract conducting business in the particular branch of trade for which he is employed.
- B. The Contractor shall not, either legally or equitably, assign any of the monies payable under the contract, or his claims thereto, unless by and with the like consent of the Engineer.

- C. The Contractor shall not be released from any of his liabilities or obligations under this contract should any subcontractor or subcontractors fail to perform in a satisfactory manner the work undertaken by him or them.
- D. The Contractor agrees that he is as fully responsible to the Owner for acts and omissions of his subcontractors, and of persons either directly or indirectly employed by them, as he is for the acts and omissions of persons directly employed by him.
- E. Nothing contained in the contract documents shall create any contractual relation between any subcontractor and the Owner.

1.46 CLAIMS FOR EXTRA COMPENSATION

- A. Should the Contractor be of the opinion, at any time or times, that he is entitled to any additional compensation whatsoever (over and above the compensation stipulated in these contract documents or for the quantities and/or amounts over and above the quantities and/or amounts allowed or approved by the Engineer for damages, losses, costs, and/or expenses alleged to have been sustained, suffered, or incurred by him in connection with the project herein contemplated, he shall, in each occurrence, within five (5) days after such alleged damages, losses, costs, and/or expenses shall have been sustained, suffered or incurred the Contractor shall file with the Engineer a written, itemized statement and/or expenses. Unless such claims and statements have been thus made and filed, in each such instance, the Contractor's claim for such additional compensation shall be held and taken to be invalidated, and he shall not be entitled to an compensation on account of such alleged damages, losses, costs and/or expenses.
- B. The provisions of these General Conditions shall beheld and taken to constitute a condition precedent to the right of the Contractor to recover; they shall also apply to all claims by the Contractor in any way relating to the complete project, and even though claims and/or work involved may be regarded as "outside the Contract."
- C. It is understood and agreed, however, that nothing in these General Conditions contained shall be held or taken to enlarge in any way the rights of the Contractor or the obligations of the Owner under these Contract documents.

1.47 EXTRA WORK RELATING TO CONTRACT

- A. No order for extra work, nor the doing of any work, at any time or place shall in any manner or to any extent relieve the Contractor or the Surety of his bond from any of their obligations under the contract documents; all extra work orders being given and all extra work being done, under and in accordance with the contract; and to be considered a part of the same and subject, to each and every one of the terms and requirements of the contract documents, and fully covered by the bond furnished by the Contractor.

1.48 SCOPE OF PAYMENTS

- A. The Contractor shall receive and accept the compensation, as provided in the Bid, in full payment for furnishing all materials, labor, tools, and equipment and for performing all

work contemplated and embraced under the contract, also for all loss or damage arising out of the nature of the work, or from the action of the elements, or from any unforeseen difficulties or obstructions, which may arise or be encountered during the execution of the work, until its final acceptance by the Owner, and for all risks of every description connected with the execution of the work; also, for all expenses incurred by, or in consequence of the suspension or discontinuance of the execution of the work as herein specified, and for any actual or alleged infringement of patent, trademark or copyright and for completing the work and the whole thereof, in an acceptable manner according to the drawings and specifications. The payment of any current or final estimate, or of any retained percentage, shall in no way or in no degree prejudice or affect the obligation of the Contractor, at his own cost and expense, to renew, or replace any defects and imperfections in the construction of the work or in the strength of or quality of materials used in or about the construction of the work under contract and its appurtenances, as well as all damage due or attributable to such defects, which defects, imperfections or damages shall be discovered on or before the final inspection and acceptance of the work, and of which defects, imperfections or damages the Engineer shall be the judge, and the said Contractor shall be liable to the Owner for failure to do so.

1.49 PARTIAL PAYMENTS

- A. The Contractor may make monthly estimates in the approved format, once each month, of the materials in place complete, and the amount of work performed in accordance with the contract, during the preceding month or period, and the value thereof figured at the unit price of the contract. In the case of lump sum items, the estimate will be on the basis of the schedule of values to be agreed upon, as hereinafter provided for. Partial payment requests shall be submitted in triplicate to the Engineer on an approved form. He shall respond within five (5) days and state his approval or request revisions.
- B. From the total of the amounts estimated will be deducted an amount equivalent to ten (10) percent of the estimated total which will be retained by the Owner until after the completion of the entire contract, in an acceptable manner; and the balance, or a sum equivalent to ninety (90) percent of that total, shall be paid to the Contractor by the Owner within thirty days after final approval of partial payment estimate by the Engineer.
- C. A schedule of values of the various parts of the work to be done under the lump sum items shall be agreed upon by the Contractor and the Engineer. Prior to the first monthly payment requisition, the Contractor shall submit for approval, a proposed breakdown into construction categories of his lump sum bid price. This breakdown shall add up to the full 100 percent value of his lump sum price, and all parts of it shall be covered by the Performance Bond. The approved breakdown shall be used for the purpose of arriving at a basis for monthly estimates and monthly billing.
- D. Mobilization and General Conditions will be proportioned according to work completed and paid as work progresses. Mobilization shall not exceed 10% of the total base bid.

- E. Each request for partial payment shall contain Contractor's certification that he has paid all Subcontractors and Materialsmen in the same proportion for all work and materials supplied by them at his own receipts.

1.50 PAYMENTS MAY BE WITHHELD

- A. Payments may at any time be withheld if the work is not proceeding in accordance with the contract, or if, in the judgment of the Engineer, the Contractor is not complying with the requirements of the contract documents.

1.51 CONDITIONAL ACCEPTANCE

- A. Whenever, in the opinion of the Engineer, the Contractor shall have the work in an acceptable manner in accordance with the terms of the contract, the Contractor shall arrange for start-up as outlined elsewhere in these specifications and an inspection of the entire work by the Engineer, and upon completion of all repairs or renewals which may appear at the time to be necessary, in the judgment of the Engineer, he shall certify to the Owner in writing as to said completion, and as to the value thereof. The aforesaid certificate shall be held and taken to evidence the conditional acceptance of the entire work by the Owner as of the date thereof. Notwithstanding the issuance of such certificate and the entire work thereunder, the Owner shall continue to reserve and retain five (5) percent of the whole value of the work as shown by the said certificate of conditional acceptance, over and above any and all other reservations and/or deductions which the Owner is, by the terms of the contract documents or otherwise, entitled or required to make and retain, and shall hold the said five (5) percent for a period of one (1) month from and after the date of such certificate of conditional acceptance. The Owner shall be authorized to apply the whole or any part of said five (5) percent so retained, to any and all costs of repairs and renewals of the work and appurtenances which may become necessary, in the judgment of the Engineer, during such period of one (1) month on account of any failure of defects in said work and appurtenances if due to improper work done or materials furnished by the Contractor, and if the Contractor shall fail to make or initiate such repairs or renewals within twenty-four (24) hours after receiving notice from the Owner to do so.

1.52 MAINTENANCE, REPAIRS, ETC., AFTER COMPLETION

- A. The Contractor, at his entire cost and expense, shall maintain all portions of the work included in this contract to meet the requirements of these specifications for and during the period one (1) month from and after the date of the conditional acceptance of the entire work by the Owner, and, in addition, shall at his entire cost and expense, make all repairs and replacements of the Engineer, at any time or times, during said one (1) month period, on account of any failures or defects in said work, equipment, controls and appurtenances due to improper work done or materials furnished by the Contractor.

1.53 FINAL ACCEPTANCE AND PAYMENT

- A. Upon the expiration of the aforesaid one (1) month period from and after the date of the certificate of conditional acceptance of the work, the Engineer shall make a final

inspection of the entire work witness and approved the satisfactory operation of the entire work witness and approve the satisfactory operation of all equipment and controls, and, upon completion of all repairs or renewals which may appear at that time to be necessary in the judgment of the Engineer, he shall certify to the Owner in writing as to the final acceptance of the entire project. The Owner, upon receipt and approval of said certificate, shall pay, or cause to be paid, to the said Contractor, under the contract, except such sums as may have been expended by the Owner under the provisions of the contract documents and less any other deductions the Owner may be otherwise entitled to make.

- B. The last mentioned certificate issued by the Engineer shall be deemed and accepted by all of the parties thereto as evidencing the final completion and acceptance of the entire project. The payment made by the Owner to the Contractor pursuant to the issuance of said certificate of final completion and acceptance shall be deemed to be and accepted by all of the parties hereto as the final payment to be made by the Owner to the Contractor; all prior certificates or estimates upon which payments may have been made being partial estimates and subject to correction in said final payment. Prior to final payment, the Contractor shall furnish a complete release of liens from individually executed by All Subcontractors and materials Suppliers.

1.54 LAST PAYMENT TO TERMINATE LIABILITY OF THE OWNER

- A. The acceptance by the Contractor of the final payment made shall operate as and be a release to the Owner and every agent thereof from all claims and liabilities to the Contractor for anything done for, furnished for, or relating to, the work, or for any act of neglect of the Owner or of any persons relating to or affecting this work.

1.55 UNLIMITED LIABILITY OF CONTRACTOR

- A. It is understood and agreed that any and all of the duties, liabilities and/or obligations imposed upon or assumed by the Contractor and the Surety, or either of them, by or under the contract documents, shall be taken and construed to be cumulative, and that the mention of any specific duty, liability or obligation imposed upon or assumed by the Contractor and/or Surety under the contract documents shall not be taken or construed as a limitation and/or obligations imposed upon or assumed by the Contractor and/or Surety by or under the contract documents.

1.56 CUMULATIVE REMEDIES

- A. All remedies provided in the contract documents shall be taken and construed to be cumulative; that is, in addition to any and all other remedies provided therein and to any remedies in law or equity which the Owner would have in any case.

1.57 CONTRACTOR'S LEGAL ADDRESS

- A. The address given in the bid or proposal is hereby designated as the legal address of the Contractor. Such address may be changed at any time by notice in writing delivered to the Owner. The delivering at such legal address or the depositing in any post office, in a postpaid, registered wrapper directed to the above-mentioned address of any notice,

letter and other communication to the Contractor, shall be deemed to be a legal and sufficient service thereof upon the Contractor.

- B. The delivering at or the mailing to the Contractor's business address (written notice of which address shall be given to the Engineer), or the delivering to the Contractor in person or to his authorized representative, of notices, letters and other communication shall also be deemed to be a legal and sufficient service thereof the Contractor.

1.58 TESTS AND INSPECTIONS

- A. If the Contract Document, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction required any Work to specifically be inspected, tested, or approved by some public body, Contractor shall assume full responsibility therefore, pay all costs in connection therewith and furnish Engineer the required certificates of inspection, testing or approval.
- B. Engineer and his representatives, representatives of Owner, OSHA, Kent Conservation District and State of Delaware officials will at reasonable times have access to the Work. Contractor shall provide proper and safe facilities for such access and observation of the WORK and also for any inspection or testing thereof by others.

1.59 COOPERATION WITH OTHER CONTRACTORS

- A. The Contractor shall cooperate with and so conduct his operations as not to interfere with or injure the work of other contractors or workmen employed by the Owner. He shall promptly make good, at his own expense, any injury or damage which may be done by him or his employees or agents on the work.
- B. The Contractor shall suspend such part of the work herein specified, or shall carry on the same in such manner, as may be ordered by the Engineer when necessary to facilitate the work of such other contractors or workmen.

1.60 GUARANTEE

- A. The Contractor hereby guarantees all of the work for a period of one (1) year after the date of completion and final acceptance thereof by the owner as follows:
 - 1. Against all faulty materials and against all imperfect, careless, and unskilled workmanship.
 - 2. That the entire equipment and each and every part thereof shall operate (with proper care and attention) in a satisfactory and efficient manner, and in accordance with the requirements of these contract documents.
 - 3. That all structures shall be watertight and leak proof at every point and in every particular.
 - 4. The Contractor agrees to replace, with proper workmanship and materials, and to reconstruct, correct, or repair, without cost to the Owner, work which is improper,

imperfect, does not operate in a satisfactory manner, or fails to perform as specified, or all of these.

5. The guarantee obligations assumed by the Contractor under these contract documents shall not be held or taken to be in any way impaired because of the specification errors, indication or approval by or on behalf of the Owner of articles, materials, means, combinations or things used in the construction, performance and completion of the work or any part thereof, or all of these.
6. No use acceptance by the Owner of the work or any part thereof, nor any failure to use the same, nor any repairs, adjustments, replacements or corrections made by the Owner due to the contractor's failure to comply with his obligations under the contract documents, shall impair in any way the guarantee obligations assumed by the Contractor under these contract documents.

- B. It is understood and agreed that in the event the Contractor fails to correct, or repair any work under the contract which may be found to be improper or imperfect, or otherwise fails to fulfill the terms of the Guarantee, the Owner may purchase materials, tools, and equipment, and employ labor, or let a contract as required to perform the necessary corrective work covered in the Guarantee. All cost and expenses incurred thereby by the Owner shall be charged against the Guarantee (Maintenance) Bond.

1.61 LIQUIDATED DAMAGES

- A. Unless otherwise specified in the contract, the sum per calendar day shall be deducted by Engineer from monies due the Contractor, not as a penalty, but as liquidated damages for the period that any work shall remain uncompleted after the time specified for the completion of the work covered by the contract.
- B. For each and every day that the Contractor is in default in completing the Contract, he shall pay the Owner the sum of \$500.00 in liquidated damages.
- C. A time allowance, however, may be made by the Engineer at his discretion, for delays caused by the conditions over which the Contractor has no control. The Contractor shall become liable for liquidated damages for delays commencing from the date on which the time allowance period shall expire.

1.62 FAILURE TO COMPLETE WORK ON TIME

- A. Permitting the Contractor to continue and finish the work or any part of it after the time established in the contract for its completion or after the date of which the time for completion may have been extended shall not operate as a waiver by the Owner of any of its right under this contract, and shall not relieve the surety from its obligation.

1.63 EXTENSION OF TIME

- A. If the Contractor finds that it will be impossible for him to complete the work on or before the completion date fixed on the contract, he shall, ten (10) days prior to said date, submit a written request to the Engineer for an extension of time for completion

of the contract. He shall set forth fully therein the reasons which he believes would justify the Engineer to grant his request, and shall set forth a revised detailed progress schedule which shall provide that the remaining work shall be completed on or before the extended completion date therein requested. If the Engineer finds that the work was delayed on account of unusual conditions beyond the control of the Contractor, or that the quantities of work done or to be done are sufficiently in excess of the estimated quantities to warrant additional time, he will, with or without notice to the surety, grant an extension of time for completion to such date as appears to him to be reasonable and proper. This date shall thereafter be as binding upon the Contractor and surety as if it appeared in the contract originally.

- B. If any delay is caused to the Contractor by specific orders of the Engineer to stop work or by the failure of the Engineer to provide necessary instruction for carrying on the work or the Owner to provide necessary right-of-way, such delay will entitle the Contractor to an equivalent suspension of the liquidated damage.
- C. When the satisfactory execution and completion of the contract requires more work or materials in greater amounts than set forth in the contract, the Contractor shall be entitled to an extension of time. When the Contractor is delayed by conditions beyond his control, the contract time shall be extended equal to the number of calendar days he has been delayed.

1.64 EXISTING WATER AND SEWERAGE SYSTEMS

- A. It is essential that the existing water and sewerage systems remain in operation throughout the construction period. Connections to existing pipes and structures shall be scheduled and coordinated with the Owner. Although some interruptions in service are impossible to avoid, the Contractor shall make every effort to keep these interruptions to a minimum.
- B. Certain connections to existing systems might have to be made during weekends or nighttime hours. No additional cost for these working hours will be allowed.

1.65 OVERTIME PAYMENT FOR RESIDENT PROJECT REPRESENTATIVE

- A. Ordinarily, an R.P.R. will be on the job at no cost to the Contractor. However, if the Contractor is performing overtime work and an R.P.R. is on the job, the Contractor shall pay the R.P.R. for his overtime hours.

1.66 LOCATION OF EXISTING UTILITIES

- A. The Contractor's attention is directed to the fact that the location of the existing utilities shown on the contract drawings are approximate only. It shall be the Contractor's responsibility to locate these utilities, by test pits in the vicinity of the utilities prior to actual construction.
- B. The failure to show on the contract drawings any existing utilities shall not relieve the Contractor of his/her responsibility of determining the locations of these utilities, and any damage to the utilities or interruption of services shall be repaired by the

Contractor according to City or utility company specifications. The Owner shall be notified of any damage to any utilities.

1.67 ORDERING MATERIALS

- A. Orders for all materials and/or equipment specified herein or shown on the drawings, or in any way affecting the work, shall be placed within ten (10) days of the signing of the contract. The Engineer shall be notified immediately if any materials or equipment are not obtainable, or promised delivery dates are such as to seriously impede the work. Substitute materials, if required, shall be subject to approval by the Engineer.
- B. Contractor shall frequently check on continued validity of delivery dates and shall advise the Engineer promptly of any change of delivery promises made by the suppliers. The Contractor shall expedite deliveries of material controlling job progress.

1.68 TEST BORINGS AND/OR SUBSURFACE CONDITIONS SHOWN ON DRAWINGS

- A. Where test borings and/or subsurface conditions are provided they have been provided, for the information of all parties concerned; however, the Owner assumes no responsibility for the accuracy of such information and should any bidder or Contractor rely on such information in preparing his bid or in the performance of the work, he does so at his own risk.
- B. Whether or not subsurface conditions are shown the Contractor is not relieved of the responsibility of making his own investigations to determine the type of subsurface materials. Where the bid or proposal stipulates unit prices, the presence or absence particular subsurface materials, or the increase or decrease in quantities specific subsurface materials, shall not entitle the Contractor to additional compensation beyond the unit prices stipulated, wherein unclassified excavation is included as a part of the proposal items.
- C. Should the Contractor encounter subsurface and/or latent conditions at the site materially differing from those shown on the plans or indicated in the specifications, he shall immediately give notice to the Engineer of such conditions before they are disturbed.

1.69 EROSION AND SEDIMENT CONTROL

- A. The Contractor shall provide for safe disposal of run-off from construction areas in accordance with County erosion and sediment control requirements. Such requirements may be defined in the Contract Documents, issued by addendum or ordered during Construction by the controlling agency, owner, or engineer. The cost of erosion and sediment control measures shall be included in the appropriate unit prices bid for pipe and appurtenances.

1.70 ACCESS BY RESIDENTS AND BUSINESSES

- A. The Contractor shall schedule his work so to minimize the time during which vehicular access to each dwelling along the work route is prevented. The Contractor shall provide, at all times, safe pedestrian access to all dwellings.
- B. Vehicular access on side streets, in the proximity of the route of the work, shall not be encumbered by the Contractor.
- C. Public access to businesses shall be provided during all periods of sewer main installation.

1.71 RECORD DRAWINGS

- A. The Contractor shall keep (1) copy of the drawings at the site, in good order and provide mark-up to show all changes made during construction. These record drawings shall be available to the Engineer, and shall be delivered to him upon completion of the Contract. The Engineer will compare the contractor's mark-up to the inspector's and prepare final record drawings for the Owner. They will contain stationing on all manholes, cleanouts, laterals to each structure, etc.

1.72 TEMPORARY UTILITY SERVICES

- A. The Contractor shall be responsible for securing water and power required, within the prices bid in the Proposal and without extra cost to the Owner.
- B. The Contractor shall be responsible for payment of all temporary electrical services, telephone services, and water services for field offices and to all residential, commercial or industrial facilities suffering a loss of such service as a result of construction activities by the Contractor until conditional acceptance of the project facilities by the Owner.

1.73 CONTRACT CLOSEOUT

- A. The items listed herein shall be compiled and prepared by the Contractor prior to completion of all work and delivered within one month of date of substantial completion to the Owner for his future use.
 - 1. Final retainage payment to the Contractor will be withheld until all items listed herein are delivered to the Owner.
 - 2. Submit all items specified herein to the Engineer or Architect for review prior to delivery to the Owner. Make any corrections, additions or deletions from the contents thereof as may be required.
- B. As-Built Drawings
 - 1. Submit As-Built Drawings as specified in this section "General Conditions", paragraph 1.12.
- C. Maintenance Manual

1. Submit Maintenance & Operations Manual as specified in Section 00 73 00 "Special Conditions", paragraph 1.08.
- D. Warranties
1. Submit all warranties for equipment & appurtenances.
- E. Asbestos Free Certification
1. The Contractor shall furnish notarized written certification to Owner that all materials installed under this contract are entirely free of asbestos.
- F. Contractor's Affidavit of Release of Liens (AIA Document G706A)
- G. Clean-Up
1. The Contractor shall, at his own expense, keep the sites of his operations clean during construction and remove all rubbish as it accumulates. Daily brush cleaning of roadway sections with ongoing construction activities shall be performed. The contractor shall remove waste materials, debris and rubbish from site periodically and dispose of at legal disposal areas away from site. The contractor shall also:
 - a. Clean staining or reactive materials from affected surfaces immediately during course of work. Particular care shall be taken to remove plaster, mortar, and paint from metal surfaced immediately.
 - b. Clean the work as it progresses to minimize the collection of dust and debris in inaccessible spaces, color change or staining of finishes, and hardening of curing-type dirt and stains.
 - c. Flush ducts of all dirt before final clean-up.
 - d. Clean on a daily basis all areas used for construction traffic. Where dropping from debris carts, concrete buggies affect traffic, assign full time labor to keep public traffic moving freely under clean, unobstructed conditions.
- H. The Contractor shall provide dust control by:
1. Cleaning interior spaces prior to start of finish painting and continue cleaning on an as-needed basis until painting is finished.
 2. Scheduling operations so that dust and other contaminates resulting from cleaning process will not fall on wet or newly-coated surfaces.
- I. The Contractor shall provide the following tasks for final cleanup:
1. Perform general cleanup of building before final inspection.
 2. Glass, porcelain, tile and similar hard surfaces shall be cleaned of sticker, tags, protective paper, marks, stains, fingerprints.

3. Floor surfaces shall be vacuum cleaned and all marks or stains removed.
4. Clean ducts of dust. Replace used filters with fresh ones.
5. Clean lighting fixtures, mirrors, and both sides of window.
6. Clean the grounds of debris and paper.
7. Clean insides and outsides of sinks.
8. Vacuum control cabinets.
9. Remove debris from roof, inlet drains, and scuppers.
10. Remove dirt splash from exterior walls at grade.
11. Remove paint spots, drips, stains, marks and dirt from all surfaces including all equipment and ductwork.
12. Refer to each Technical Section of the Specifications for additional requirements

1.74 BUILDING CODES

- A. The contractor shall conform to 1988 Standard Building Code and 1989 NFPA 101 Life Safety Code. If the contractor discovers questionable deviation from these code requirements, the contract is then required to notify the architect for conformation.
- B. The Contractor shall conform to safety standards as set forth by the "Manual of Accident Prevention in Construction by Associated General Contractors of America, Inc.," and OSHA.

1.75 PROJECT MEETINGS

- A. The Engineer may keep minutes of project meetings and will distribute copies to all parties present at meeting or listed on a permanent list of concerned parties.
- B. Except as noted below for preconstruction meeting, progress meetings will be scheduled on a regular basis by the Engineer.
- C. The Engineer may call additional progress meetings at critical times in the project.
- D. The Contractor shall schedule the presence of active and critical suppliers, subcontractors, and management personnel at these meetings.
- E. Representatives of the Contractor's suppliers and subcontractors shall be persons familiar with the details of the work. They shall be person authorized to make commitments on matters of work progress, delivery dates, size of labor force, cost and other matters as necessary to expedite the work.
- F. To the maximum extent practicable, meetings will be held at the job site.

- G. A preconstruction meeting will be scheduled within ten (10) days after the Owner has issued the Notice to Proceed.
- H. Contractor shall provide attendance by authorized representatives of the Contractor and all major subcontractors.

1.76 PHOTOGRAPHS

- A. Each month during the construction phase of the project, the Contractor shall have taken, four (4) 5-inch by 7-inch color photographs representing four different views of significant items of work then in progress. Two prints of each photograph clearly labeled as to project title and date taken shall be delivered to the Engineer.

1.77 MATERIAL AND EQUIPMENT

- A. Piled material such as sand, gravel, excavating and topsoil shall be stored in such a way that silting and staining of surroundings from rain will not occur. Cover aggregate piles in cold and wet weather.
- B. Unit materials such as CMU, brick, steel, pipe, conduit, door frames and lumber shall be stored off ground, out of reach of water, mud and splashing. CMU shall be separated in piles according to grade and shall be kept dry, covered top and sides, at all times.
- C. Solid materials such as insulation, tile, mechanical and electrical equipment, fittings and fixtures shall be stored under shelter, in original packages, away from dampness and other hazards. Liquid materials shall be stored in original tanks or cans, with labels protected. Protect water mixes from freezing. Keep flammables away from fire and heat. Provide sufficient open shelving for storage of all finish hardware, together with work surface for assembly.
- D. Provide special storage for sensitive materials as follows and as further specified in other section.
 - 1. Cement, lime: In an absolutely dry place.
 - 2. Millwork, doors, casework: In heated area, after wet materials such as plaster have dried 30 days.
 - 3. Thinners, paint rags: Isolated from paint, in well ventilated space.
 - 4. Bottles, gases and power fasteners: Isolated from heat and fire, away from thinners and petroleum products.
- E. Tools and Equipment
 - 1. Store tools that carry dirt, or leak oil, outside.
 - 2. When pipe threading machines or other oily machines or processes are used inside building, they shall be placed on a layer of absorptive fiber board with plastic sheet beneath so as not to stain floors.

3. Large equipment shall be stored or parked so as not to damage site or present a fire hazard to the building.

END OF SECTION 00720

SECTION 00730

SPECIAL CONDITIONS

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1.01 ORGANIZATIONAL DEFINITIONS

- A. Engineer: City of Dover's consultant engineer is AECOM. The Engineer is acting for the Owner as its duly authorized agent, said agent acting severally within the scope of duties contracted for with the owner.
- B. Wherever the word Owner appears in the Contract Documents, it is defined to mean the City of Dover, Delaware.
- C. Key personnel involved in traffic control must be certified by DeIDOT prior to commencement of construction.

1.02 DRAWINGS AND SPECIFICATIONS

- A. Wherever the words "directed", "required", "ordered", "approved", "acceptable", or others of like import appear in the specifications, they shall mean as directed, required, ordered, approved or acceptable by or to the Owner and by or to the Engineer acting as the Owner's agent.
- B. All reference to Federal or other standards appearing on the drawings or in the specifications shall mean the current edition. Where, in the specifications which follow, a standard is cited next to the name of a product or a test procedure, the product or test procedure shall conform to that standard.
- C. Unless otherwise noted in General Conditions, two (2) sets of specifications will be furnished the Contractor without charge. Additional sets will be furnished at cost.
- D. The Contractor shall maintain, at the job site, one complete set of specifications. The Contractor shall record on this set and keep current, all authorized changes and field adjustments. The set shall be kept available for inspection by representatives of the Owner and the Engineer, and shall finally be used to assist in the preparation of as-built drawings.
- E. Locations of overhead and underground utilities shown on the drawings were derived from existing records and from field observations, in order to provide the Contractor with as much information as could reasonably be ascertained without actually excavating and exposing subsurface utilities. The Owner and the Engineer do not warrant or guarantee the complete accuracy of the information shown. Some utilities may not be shown, and the location of those shown may not be entirely accurate.
- F. All incidental items of labor and materials not specifically delineated by the Contract Documents, but which are necessary to provide a fully operable facility, and which may reasonably be interpreted as being a part of the work shall be accomplished by the Contractor without extra charge.

1.03 CONTRACT TIME

- A. The Bid Form states the number of consecutive work days allowed from date of "Notice to Proceed" to date of completion of the entire project under this Contract. For each and every day

that the Contractor is in default in completing the Contract, as defined in the General Conditions and the bid, he shall pay the Owner the sum of \$500.00 in liquidated damages.

- B. The Owner reserves the right to take either or both of the following actions at any time, that in his judgment, it appears the scheduled completion date will not be met:
 - 1. Require the Contractor to assign additional construction forces to the work.
 - 2. Delete all or any portion of remaining work from this Contract and assign such work to another Contractor or accomplish same by any other method which may appear most advantageous.
 - 3. These remedies are supplementary to all other provisions of the specifications and do not void such other provisions.

1.04 SUBCONTRACTING

- A. The Contractor shall submit, prior to commencement of construction for review by the Owner, a final list of Subcontractors, as well as materials and equipment suppliers with whom he intends to contract. If the Owner or the Engineer objects to any proposed Subcontractor, materials or equipment supplier, the Contractor shall furnish such data as may be required to secure the Owner's and Engineer's approval. If such approval is not then forthcoming, the Owner and the Contractor will negotiate the matter to a mutually acceptable conclusion, which negotiations may include a decrease or increase in contract price.

1.05 SURVEYS AND CONSTRUCTION STAKE-OUT

- A. Any bench marks or property corners destroyed through or as a direct result of the Contractor's construction operations shall be replaced and/or restored at his expense with no additional cost to the Owner by a surveyor licensed in the State of Delaware.
- B. All proposed valves, meter pits, etc., shall be field located by the Contractor prior to the start of construction. Notice shall be given to the Owner to observe the location and make any adjustments deemed necessary.
- C. Any bench marks or property corners destroyed through or as a direct result of the Contractor's construction operations shall be replaced and/or restored at his expense with no additional cost to the Owner by a surveyor licensed in the State of Delaware.

1.06 CONSTRUCTION SCHEDULE

- A. The Contractor shall submit a construction schedule indicating anticipated date of beginning and completion of each work increment and indicating completion of all increments by the scheduled date. The Contractor shall assign such work forces as are necessary to accomplish all increments of the work within the times allotted on the construction schedule.
- B. Once the construction schedule has been approved by the Owner, the Contractor shall adhere to the approved construction sequence. In the event that unforeseen circumstances require the

sequence to be adjusted, the Contractor shall make such request to the Owner in writing and shall not change the sequence prior to receipt of approval.

1.07 SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION

- A. In order to protect the lives and health of his employees under the contract, the Contractor shall comply with all pertinent provisions of the Contract Work Hours and Safety Standards Act, as amended, commonly known as the Construction Safety Act as pertains to health and safety standards; and shall maintain an accurate record of all cases of death, occupational disease, and injury requiring medical attention or causing loss of time from work arising out of and in the course of employment on work under contract.
- B. The Contractor, alone, shall be responsible for the safety, the adequacy of his work, appliances, and methods, and for any damage which may result from their failure or their improper construction, maintenance or operation. The Contractor will comply, within the prices bid and without extra cost to the Owner, with all safety regulations or determinations issued by any agency of the Federal government including OSHA and the State of Delaware.

1.08 SHOP DRAWINGS

- A. The Contractor shall submit to the Owner layout drawings for installation and erection of the work, and shop drawings for all fabricated or manufactured articles to be used in the work. The Contractor shall have six (6) copies prepared for submittal to the Owner and shall prepare whatever additional copies as may be necessary or required for his own use and/or use by individual equipment suppliers and Subcontractors.
- B. All shop drawings shall be submitted to the Owner through the Contractor. Direct submittals by the Subcontractors will not be accepted. The Contractor shall review and sign each copy of a shop drawing noting review and approval prior to submittal. Drawings will not be considered unless they have been stamped approved by the Contractor.
- C. The Owner's review of layout and shop drawings will be only to verify general compliance with Contract Documents. Figure dimensions and other detail will not be checked. Any notation made on shop drawings by the Owner shall be for the Contractor's guidance, but shall not relieve the Contractor from his responsibility to re-check, verify and resolve items so noted. The Owner's review of shop drawings shall not relieve the Contractor from responsibility for errors or omissions thereon, whether or not called to the attention of the Contractor by the Owner.

1.09 OPERATING AND MAINTENANCE MANUAL

- A. Compile product and related information appropriate for Owner's maintenance and operation of products furnished under the contract as specified in this section and as referenced in other pertinent sections of the Specifications.
- B. Instruct Owner's personnel in the maintenance of products and in the operation of equipment and systems.
- C. Form of Submittals: Prepare data in the form of an instructional manual for use by Owner's personnel. Text shall be manufacture's printed data or neatly typewritten on 8.5 x 11 inch white

pages. Drawings shall be folded as required and provided with a reinforced punched binder tab. Provide fly-leaf for each separate product or piece of equipment commercial quality three-ring binders with durable and cleanable plastic covers. Maximum ring size is three (3) inches. All binders shall have a printed title "Operating and Maintenance Manual" and in addition, the project title and general subject matter covered within.

D. Content of Manual:

1. Neatly typewritten Table of Contents for each volume, arranged in a systematic order as follows: Contractor, name of responsible principal, address and telephone number; a list of each product required to be included, indexed to the content of the volume; list, subcontractor or installer, maintenance contractor, as appropriate, identify the area of responsibility, of each local source of supply for parts and replacement; and identify each product by product name and other identifying symbols as set forth in the Contract Documents.
2. Product Data: Include only those sheets which are pertinent to the specific product and note each sheet to clearly identify the specific product and note each sheet to clearly identify the data applicable to the installation. Delete references to inapplicable information.
3. Drawings: Supplement data with drawings as necessary to clearly illustrate relations of component parts of equipment and systems, and control, wiring and flow diagrams. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation. Do not use Project Record Documents as maintenance drawings.
4. Written text, as required to supplement product data for the particular installation; organize in a consistent format under separate headings for different procedures and provide a logical sequence of instructions for each procedure.

E. Manual for Materials and Finishes: Submit three (3) copies of the complete manual containing, for architectural products, manufacturer's data, catalog number, size, composition, color, texture designation, and, information required for re-ordering special manufacturer parts for all applied materials and finishes. Also included shall be manufacture's recommendations for care and maintenance, moisture protection and weather exposure precaution, and instructions on repair where applicable.

F. Submittal Schedule: Manuals shall be submitted and approved prior to start-up for testing of the station.

G. Instruction and Training of Owner's Personnel: Instruction and Training shall be completed prior to acceptance for operational by the City.

1.10 CONSERVATION DISTRICT REQUIREMENTS

A. The Contractor shall comply with all provisions of the sediment and erosion control plan and all directives issued by the agency or their inspectors.

1.11 TESTS AND INSPECTIONS

- A. If the Contract Documents, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction require any Work to specifically be inspected, tested, or approved by some public body, the CONTRACTOR shall assume full responsibility, therefore, pay all costs in connection therewith and furnish OWNER the required certificates of inspection, testing or approval.
- B. ENGINEER and his representatives, representatives of OWNER, the Kent County Soil Conservation Service, OSHA, Office of Drinking Water and Department of Natural Resources and Environmental Control will at reasonable times, have access to the WORK. CONTRACTOR shall provide proper and safe facilities for such access and observation of the Work and also for any inspection or testing thereof by others.

1.12 SALVAGE

- A. Contractor shall coordinate with the City of Dover to verify any and all items to be salvaged from the existing pump station and force main.

1.13 UNSCHEDULED WORK ACTIVITIES

- A. Sufficient time for construction has been indicated and it is intended that all work specified under these Contract Documents be performed within the normal daily working hours of 7:00 A.M. to 3:30 P.M., Monday through Friday, unless authorized by the Director of Public Works.. An alternate continuous daily work period may be satisfactory, however, subject to approval of the Owner.
- B. Should the Contractor extend his work beyond these specified hours, any and all cost of weekend, holiday and/or overtime inspection incurred by the Engineer or Owner will be the sole obligation of the Contractor.

1.14 PROTECTION OF PROPERTY AND STRUCTURES

- A. The Contractor shall, at his own expense, sustain in their places an protect from direct or indirect injury all pipes, wires, conduits, poles, tracks, walls, buildings, and other structures or property in the vicinity of his work whether above or below the ground, or that may appear in the trench. He shall at all times have sufficient quantity of timber and plank, chains, ropes, etc., on the site and shall use them as necessary for sheeting his excavations and for sustaining or supporting any structures that are uncovered, undermined, endangered, threatened, or weakened. The Contractor shall take all risks attending the presence of proximity of pipes, wires, conduits, poles, tracks, walls, buildings or other structures and property of every kind and description in or over his trenches or in the vicinity of his work whether above or below the surface ground and he shall be responsible for all damage and assume all expense for direct or indirect injury caused by his work. To any of them or to any person or property by reason of injury to them, whether such structures are or are not shown on the drawings.
- B. The Contractor shall take all necessary precautions to protect existing fences, property markers, driveways, curbing, sidewalk, etc., including the replacement of any said items damaged through or as a result of the Contractor's operations to the satisfaction of the property owner

and the Owner. The Contractor shall coordinate and pay for replacement of property monuments damaged. This work shall be performed by a surveyor licensed in the State.

- C. The Contractor shall not enter upon private property for any purpose without obtaining the property owner's permission and he shall be responsible for the preservation of all public and private property, trees, shrubbery, and any and all natural or manmade objects, along and adjacent to the work and shall use every precaution necessary to prevent damage or injury to any and all property. The Contractor shall not willfully or maliciously injure or destroy trees or shrubs and shall not remove or cut them without proper written authority of the property owner. The Contractor shall be strictly responsible for any and all damage or injury of every kind and description which directly or indirectly may be done to any property or sustained by any persons during the prosecution of the work resulting from any wrong doing, misconduct, poor construction methods, or any negligence of himself or his agents and/or employees in his manner or method of executing said work or due to his non-execution of said work, even though such manner or method of said work be concurred in, permitted, or allowed by the Engineer or the Owner, its agents, and/or employees, or at any time due to defective work or material. When or where any direct or indirect damage or injury is done to public or private property, by or on account of any act, construction method, omission, neglect or misconduct in the execution of the work, or in consequence of the non-execution thereof on the part of the Contractor, he shall restore, at his own expense, such property to a condition equal to that existing before such damage or injury was done by repairing, rebuilding, or otherwise restoring as may be directed, or he shall make good such damage or injury in an acceptable manner. In case of the failure on the part of the Contractor to restore such property or make good such damage or injury, the Owner may, upon forty-eight (48) hours' notice, proceed to repair, rebuild, or otherwise restore such property as may be deemed necessary, and the cost thereof may be deducted from any money due or which may become due the Contractor under this Contract. No extension of the Contract time will be allowed for any work or restoration covered by these requirements.

1.15 CONTRACTOR'S AND SUBCONTRACTOR'S INSURANCE

- A. As required under paragraph 1.04 of the General Conditions, the Contractor's Public Liability Insurance and Vehicle Liability Insurance shall be in an amount not less than \$1,000,000 for injuries, including accidental death, to any one person and subject to the same limit for each person, in an amount not less than \$1,000,000 on account of one accident, and Contractor's Property Damage Insurance in an amount not less than \$1,000,000.
- B. The Contractor shall either (1) require each of his Subcontractors to procure and to maintain during the life of his subcontract, Subcontractor's Public Liability and Property Damage Insurance of the type and in the same amounts as specified in the preceding paragraph, or (2) insure the activities of his Subcontractors in his own policy.

1.16 PAYMENTS TO CONTRACTOR

- A. Each request for payment shall contain Contractor's certification that he has paid all Subcontractors and Materialmen in the same proportion for all work and materials supplied by them at his own receipts.
- B. Prior to final payment, the Contractor shall furnish a complete release of liens individually executed by each Subcontractor and Materialmen involved in the Project.

1.17 STORED MATERIALS

- A. The Contractor will be compensated monthly for only the materials in-place, complete, and will not be compensated for materials stored. In the case of lump sum items, monthly compensation will be on the basis of the schedule of values to be agreed upon prior to beginning construction.

1.18 SCHEDULES, REPORTS AND RECORDS

- A. All items of work which required measurement shall be measured concurrently, upon installation and before covering or backfilling by the Owner's representative and the Contractor's Representative. All items so measured will be recorded by both parties in a format which can be kept current until completion of the work.
- B. Such measurement records shall be utilized to formulate and check partial and final requests for payment. Upon completion of the work, both sets of records shall be delivered to the Owner for his use in the preparation of as-built drawings.
- C. All measurements, to the maximum extent possible, shall be reference to base dimensions and stationing shown on the drawings.

1.19 ACCESS BY RESIDENTS

- A. The Contractor shall so schedule his work so to minimize the time during which vehicular access to each dwelling along the work route is prevented. The Contractor shall provide, at all times, safe pedestrian access to all dwellings.
- B. Vehicular access on side streets, in the proximity of the route of the work, shall not be encumbered by the Contractor.
- C. The Contractor shall not totally bar vehicle access from more than one block of the route of the work at any given time. Access to businesses shall always be maintained.

1.20 ACCOMMODATION OF TRAFFIC

- A. In carrying out the work the Contractor shall interfere as little as possible with traffic. The Contractor shall provide and maintain ingress and egress for all residences and places of business located along the construction route. So far as practical, materials shall not be stored upon the highway. When it is absolutely necessary to do so they shall be placed so as to cause as little obstruction to the traveling public as possible.
- B. If, in the opinion of the Owner, it is necessary to keep the road or any portion of the road open to travel during the construction, the Contractor shall carry on his work in such a manner as to provide such means that travel will not be obstructed or endangered.
- C. The Contractor shall provide and maintain, in an acceptable condition, such temporary roadways and bridges as may be necessary to accommodate the traffic using or diverted from a roadway where construction is taking place. He shall also provide and maintain, in a safe condition temporary approaches to and crossings of intersecting roadways.

- D. Fire hydrants on or adjacent to the highway shall be kept accessible to fire apparatus at all times and no material or obstruction shall be placed within fifteen feet of any such hydrant. All footways, gutters, sewers, inlets, and portions of the roadway adjoining the construction shall be kept free of obstructions insofar as possible.
- E. Work areas closed down for any length of time shall be left entirely accessible at all points to fire apparatus.
- F. The Contractor shall not disturb the surface of an existing road further in advance of the new construction than can be completed in a reasonable length of time as determined by the Owner.

1.21 DETOURS

- A. Detours are to be installed by the Contractor. Traffic will be detoured over approved routes along existing roads upon written approval of the Engineer, the Owner and the Delaware Department of Transportation (DeDOT). Cost of erection and maintenance of the detour signs, etc. is to be borne by the Contractor.
- B. The Contractor shall notify DeDOT, local fire companies and the City of all proposed detours 7 days prior to implementation and permit alternate routes in case of emergency.

1.22 CONSTRUCTION IN RIGHTS-OF-WAY

- A. All permanent construction will be within lands of the Owner, public Rights-of-Way or Rights-of-Way through private property acquired by the Owner and the Contractor shall confine his operations strictly within the limits of the Right-of-Way and construction areas, unless he has written permission of the owner of the adjacent property to occupy additional ground. A copy of the written permission shall be placed on file with the Owner.

1.23 ELIMINATED ITEMS

- A. Should any items contained in the Project be found unnecessary for the proper completion of the work contracted, the Owner may, upon written order to the Contractor, eliminate such items from the contract and such action shall in no way invalidate the contract, and no allowance will be made for the items so eliminated in making final payment to the Contractor except for such actual work as may have been done, and materials actually purchased.

1.24 QUANTITIES OF ESTIMATE

- A. Whenever the estimated quantities of work to be done and materials to be furnished on a unit price basis under this contract are shown in any of the documents including the bid, they are given for use in comparing bids, and the right is expressly reserved, except as herein otherwise specifically limited, to increase or diminish them as may be deemed reasonably necessary or desirable by the Owner to complete the work contemplated by this contract, nor shall any such increase or diminution give cause for claims or liability for damages

1.25 GUARANTEE BOND

- A. Prior to final payment, the Contractor will be required to furnish the Owner with a one year Guarantee Certificate and a Guarantee Bond in the amount of 100 percent of the total bid. The bond must be effective for the one year guarantee period beginning on the date of final acceptance by the Owner.
- B. It is understood and agreed that in the event the Contractor fails to correct, or repair any work under the contract which may be found to be improper or imperfect, or otherwise fails to fulfill the terms of the Guarantee, the Owner may purchase materials, tools, and equipment, and employ labor, or let a contract as required to perform the necessary corrective work covered in the Guarantee. All cost and expenses incurred thereby by the Owner shall be charged against the Guarantee Bond. An extension of the Performance Bond for the guarantee period in lieu of the Guarantee Bond is acceptable with proper documentation from the Surety.

1.26 REFERENCED SPECIFICATION

- A. Where reference is made to Delaware Department of Transportation (DelDOT) Specification it shall mean the Standard Specification for Construction and Materials, latest edition.

1.27 WAGE RATES

- A. State of Delaware prevailing wage rates and Davis Bacon wage rates apply.

1.28 UTILITIES

- A. The Contractor shall do all work within the lump sum price bid and without extra cost to the Owner, which is required to locate, protect, relocate, replace or repair all overhead and underground utilities shown or not shown on the drawings, as necessary for the construction of this project. He shall contact "Miss Utility" at 800-282-8555 at least 48 hours prior to digging in the vicinity of existing underground utilities to have them located and marked.
- B. The Contractor shall, within the unit prices bid and without extra cost to the Owner, pay all charges levied by utility companies for work performed by their forces to locate, inspect, protect, relocate, replace or repair overhead or underground utilities as necessary for the construction of this project.

1.29 EXISTING WATER AND SEWERAGE SYSTEMS

- A. It is essential that the existing water and sewer systems remain in operation throughout the construction period. Connections to existing pipes and structures shall be scheduled and coordinated with the Owner. Although some interruptions in service are impossible to avoid, the Contractor shall make every effort to keep these interruptions to a minimum.

1.30 CONTRACTOR RESPONSIBILITY TO COORDINATE ALL SERVICES

- A. During construction, testing, start-up and initial operation, and during the one year guarantee period, Contractor is solely responsible for coordinating the efforts of all parties responsible for work under this Contract. Should problems arise, Contractor shall promptly perform all tests

necessary to trouble shoot and identify the problems and assure repairs are made by the appropriate Subcontractors or suppliers as required to remedy any faults. Contractor shall respond to request for services from the Owner or Engineer as soon as possible, but in no case, longer than 24 hours after receiving such request whenever a problem arises which affects the proper operation of the water main. The fault or defect shall be remedied as soon as possible. The Contractor shall provide emergency substitute equipment at his expense, if necessary, to keep the system operational during troubleshooting or repairs and shall bear all costs associated with such efforts.

1.31 WATER AND POWER

- A. The Contractor shall be responsible for securing water and power required, within the prices bid in the bid form and without extra cost to the Owner. Both are available from the City of Dover at cost.
- B. Water supply shall be obtained at the filling station located at 710 William Street, Dover, DE 19904. Water cannot be obtained through use of a fire hydrant.

END OF SECTION 00730

American Iron and Steel (AIS) Requirement

Consolidated Appropriations Act, 2014 (Act), includes an “American Iron and Steel (AIS)” requirement in section 436 that requires Clean Water State Revolving Loan Fund (CWSRF) and Drinking Water State Revolving Loan Fund (DWSRF) assistance recipients to use iron and steel products that are produced in the United States for projects for the construction, alteration, maintenance, or repair of a public water system or treatment works if the project is funded through an assistance agreement executed beginning January 17, 2014 (enactment of the Act), through the end of Fiscal Year 2014.

Implementation:

The Act states:

Sec. 436. (a)(1) None of the funds made available by a State water pollution control revolving fund as authorized by title VI of the Federal Water Pollution Control Act (33 U.S.C. 1381 et seq.) or made available by a drinking water treatment revolving loan fund as authorized by section 1452 of the Safe Drinking Water Act (42 U.S.C. 300j-12) shall be used for a project for the construction, alteration, maintenance, or repair of a public water system or treatment works unless all of the iron and steel products used in the project are produced in the United States.

(2) In this section, the term “iron and steel products” means the following products made primarily of iron or steel: lined or unlined pipes and fittings, manhole covers and other municipal castings, hydrants, tanks, flanges, pipe clamps and restraints, valves, structural steel, reinforced precast concrete, and construction materials.

(b) Subsection (a) shall not apply in any case or category of cases in which the Administrator of the Environmental Protection Agency (in this section referred to as the “Administrator”) finds that—

(1) applying subsection (a) would be inconsistent with the public interest;

(2) iron and steel products are not produced in the United States in sufficient and reasonably available quantities and of a satisfactory quality; or

(3) inclusion of iron and steel products produced in the United States will increase the cost of the overall project by more than 25 percent.

(c) If the Administrator receives a request for a waiver under this section, the Administrator shall make available to the public on an informal basis a copy of the request

and information available to the Administrator concerning the request, and shall allow for informal public input on the request for at least 15 days prior to making a finding based on the request. The Administrator shall make the request and accompanying information available by electronic means, including on the official public Internet Web site of the Environmental Protection Agency.

(d) This section shall be applied in a manner consistent with United States obligations under international agreements.

(e) The Administrator may retain up to 0.25 percent of the funds appropriated in this Act for the Clean and Drinking Water State Revolving Funds for carrying out the provisions described in subsection (a)(1) for management and oversight of the requirements of this section.

(f) This section does not apply with respect to a project if a State agency approves the engineering plans and specifications for the project, in that agency's capacity to approve such plans and specifications prior to a project requesting bids, prior to the date of the enactment of this Act.

Iron / Steel Products:

For purposes of the CWSRF and DWSRF projects that must comply with the AIS requirement, an iron or steel product is one of the following made primarily of iron or steel that is permanently incorporated into the public water system or treatment works:

- Lined or unlined pipes or fittings;
- Manhole Covers;
- Municipal Castings (defined in more detail below);
- Hydrants;
- Tanks;
- Flanges;
- Pipe clamps and restraints;
- Valves;
- Structural steel (defined in more detail below);
- Reinforced precast concrete; and
- Construction materials (defined in more detail below).

'Primarily iron or steel' places constraints on the list of products above. For one of the listed products to be considered subject to the AIS requirements, it must be made of greater than 50% iron or steel, measured by cost. If one of the listed products is not made primarily of iron or steel, United States (US) provenance is not required.

Steel means an alloy that includes at least 50 percent iron, between .02 and 2 percent carbon, and may include other elements. Often, other metals are added to give steel a particular property, such as chromium and nickel to make it stainless.

Production in the United States of the iron or steel products used in the project requires that all manufacturing processes, including application of coatings, must take place in the United States, with the exception of metallurgical processes involving refinement of steel additives. All manufacturing processes includes processes such as melting, refining, forming, rolling, drawing, finishing, fabricating and coating. Further, if a domestic iron and steel product is taken out of the US for any part of the manufacturing process, it becomes foreign source material. However, raw materials such as iron ore, limestone and iron and steel scrap are not covered by the AIS requirement, and the material(s), if any, being applied as a coating are similarly not covered. Non-iron or steel components of an iron and steel product may come from non-US sources. For example, for products such as valves and hydrants, the individual non-iron and steel components do not have to be of domestic origin.

Municipal Castings :

Municipal castings are cast iron or steel infrastructure products that are melted and cast. They typically provide access, protection, or housing for components incorporated into utility owned drinking water, storm water, wastewater, and surface infrastructure. They are typically made of grey or ductile iron, or steel. Examples of municipal castings are:

- Access Hatches;
- Ballast Screen;
- Benches (Iron or Steel);
- Bollards;
- Cast Bases;
- Cast Iron Hinged Hatches, Square and Rectangular;
- Cast Iron Riser Rings;
- Catch Basin Inlet;
- Cleanout/Monument Boxes;
- Construction Covers and Frames;
- Curb and Corner Guards;
- Curb Openings;
- Detectable Warning Plates;
- Downspout Shoes (Boot, Inlet);
- Drainage Grates, Frames and Curb Inlets;
- Inlets;
- Junction Boxes;
- Lampposts;
- Manhole Covers, Rings and Frames, Risers;
- Meter Boxes;
- Steel Hinged Hatches, Square and Rectangular;
- Steel Riser Rings;
- Trash receptacles;
- Tree Grates;
- Tree Guards;
- Trench Grates; and

Valve Boxes, Covers and Risers.

Structural steel is rolled flanged shapes, having at least one dimension of their cross-section 3 inches or greater, which are used in the construction of bridges, buildings, ships, railroad rolling stock, and for numerous other constructional purposes. Such shapes are designated as wide-flange shapes, standard I-beams, channels, angles, tees and zees. Other shapes include H-piles, sheet piling, tie plates, cross ties, and those for other special purposes.

Construction materials are those articles, materials, or supplies made primarily of iron and steel, that are permanently incorporated into the project, not including mechanical and/or electrical components, equipment and systems. Some of these products may overlap with what is also considered “structural steel”. This includes, but is not limited to, the following products: wire rod, bar, angles, concrete reinforcing bar, wire, wire cloth, wire rope and cables, tubing, framing, joists, trusses, fasteners, welding rods, decking, grating, railings, stairs, access ramps, fire escapes, ladders, wall panels, dome structures, roofing, ductwork, surface drains, cable hanging systems, manhole steps, fencing and fence tubing, guardrails, doors, gates, and screens.

The following examples are NOT considered construction materials: gear reducers, drives, mixers, heat exchangers, pumps, motors, blowers/aeration equipment, meters, variable frequency drives (VFDs), valve actuators, controls, supervisory control and data acquisition (SCADA), membrane bioreactor systems, membrane filtration systems, filters, disinfection systems, belt presses, HVAC (excluding ductwork), water heaters, generators, cabinetry and housings, lighting fixtures, electrical conduit, emergency life systems, metal office furniture, shelving, laboratory equipment, and analytical instrumentation.

For purposes of construction of the project, yes, welding rods are a construction material and must be produced in the US. Additionally, if welding rods are used in the production of a listed product, that welding rod used by a manufacturer, fabricator, etc., must also be produced in the US.

While reinforced precast concrete may not be at least 50% iron or steel, in this particular case, the reinforcing rebar must be produced in the US and meet the same standards as for any other iron or steel product. Additionally, the casting of the concrete product must take place in the US. If the reinforced concrete is cast at the construction site, the reinforcing rebar is considered to be a construction material and must be produced in the US.

Compliance Documentation:

In order to ensure compliance with the AIS requirement, the step certification process shall be used. The step certification process is a method used to ensure adherence to AIS requirements and establish accountability.

Step certification creates a paper trail which documents the location of the manufacturing process involved with the production of steel and iron materials. A step certification is a process under which each handler (supplier, fabricator, manufacturer, processor, etc) of the iron and steel products certifies that their step in the process was domestically performed. Each time a step in the manufacturing process takes place, the manufacturer delivers its work along with a certification of its origin. A certification can be quite simple. It should include the name of the manufacturer, the location of the manufacturing facility where the product or process took place (not its headquarters), a description of the product or item being delivered, and a signature by a manufacturer's responsible party.

Alternatively, the final manufacturer that delivers the iron or steel product to either the worksite, vendor, or contractor, may provide a certification asserting that all manufacturing processes occurred in the US. While this type of certification may be acceptable, it does not provide the same degree of assurance. Additional documentation may be needed if the certification is lacking important information.

Sample Certification for Step Certification Process

The following information is provided as a sample letter of step certification for Buy America compliance. Documentation must be provided on company letterhead.

Date

Company Name

Company Address

City, State Zip

Subject: Buy America Step Certification for Project (XXXXXX-XXXXXXA)

I, (company representative), certify that the (melting, bending, coating, galvanizing, cutting, etc.) process for (manufacturing or fabricating) the following products and/or materials shipped or provided for the subject project is in full compliance with the American Iron and Steel requirement as mandated in EPA's State Revolving Fund Programs.

Item, Products and/or Materials:

1. XXXX
2. XXXX
3. XXXX

If any of the above compliance statements change while providing material to this project we will immediately notify the prime contractor and the engineer.

Signed by company representative



Delaware Health and Social Services



Office of Engineering

Drinking Water State Revolving Fund (DWSRF)

Program Requirements

REVISED MAY 2013

**DRINKING WATER STATE REVOLVING FUND
PROGRAM REQUIREMENTS
PART A:
Prevailing Wage Regulations**

The Project or Program to which the work covered by this contract pertains to is being assisted by the State of Delaware and the following provisions are included in this Contract pursuant to the provisions applicable to such SRF Program. Loan Recipients or engineering representatives are to notify the State of Delaware Department of Labor to verify the appropriate wage determination before they go out for competitive bidding. A copy of the Delaware Prevailing Wage Regulations may be obtained from the State of Delaware Department of Labor by calling **(302) 761-8200** or by writing to this address:

**State of Delaware
Department of Labor
225 Corporate Blvd. Suite 104
Newark, De 19702**

As of 2010 all DWSRF projects will also be required to pay wage rates according to Davis-Bacon wage rates and/or Delaware State wage rates. When considering which rate to use for a classification the higher of the two rates shall be used. If only one of the wage rates has the classification for the job task that is the rate to be used.

The Davis Bacon wage rate determination can be obtained at:

<http://www.gpo.gov/davisbacon/>

DRINKING WATER STATE REVOLVING FUND PROGRAM REQUIREMENTS

PART B: Equal Employment Opportunity

I. Executive Order 11246 (Contracts/subcontracts above \$10,000)

(A). During the performance of this contract, the contractor and all subcontractors agree as follows:

(1). The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited to the following: employment upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of the nondiscrimination clause.

(2). The contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive considerations for employment without regard to race, color, religion, sex, or national origin.

(3). The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the said labor union or workers' representatives of the contractor's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4). The contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.

(5). The contractor will furnish all information and reports required by the Executive Order 11246 of September 24, 1965, and by rules, regulations, and orders of the Secretary of Labor, or pursuant to thereto, and will permit access to his books, records, and accounts by the

administering agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6). In the event of the contractors' noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this contract may be cancelled, terminated, or suspended in whole or in part and the contractor may be declared ineligible for further Government contracts or federally-assisted construction contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

(7). The contractor will include the portion of the sentence immediately preceding Paragraph (1) and the provisions of Paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The contractor will take such action with respect to any subcontract or purchase orders as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance. Provided; however, that in the event a contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the administering agency the contractor may request the United States to enter into such litigation to protect the interests of the United States.

DRINKING WATER STATE REVOLVING FUND PROGRAM REQUIREMENTS

PART C:

Notice to Prime Contractor of Requirement for Certification of Nonsegregated Facilities

Bidders and offerers are cautioned as follows: By signing this bid or offer, the bidder or offerer will be deemed to have signed and agreed to the provisions of the "Certification of Nonsegregated Facilities" in this solicitation. The certification provides that the bidder or offerer does not maintain or provide for his employees' facilities which are segregated on a basis of race, creed, color, or national origin, whether such facilities are segregated by directive or on a de facto basis. The certification also provides that he will not maintain such segregated facilities.

DRINKING WATER STATE REVOLVING FUND PROGRAM REQUIREMENTS

PART D: Construction Contractors Requirements

(1). Whenever the contractor or any subcontractor at any tier subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract, the provisions of these specifications and the Notice to which contains the affirmative action goals for minority and female participation, as is set forth in the solicitations from which this contract resulted.

(2). The fair share objective for the Delaware State Revolving Fund Program is as follows:

Statewide – 16% MBE / 8% WBE

(3). The MBE/WBE goals set forth in the contract are shown in #2 above. The contractor shall make every reasonable attempt to achieve the goals as stated. When so notified by the owner, the apparent low bidder shall provide a listing of MBE's and WBE's he proposes to use on this project. Should the bidder fail to meet the aforementioned objectives, he shall provide complete documentation which demonstrates the positive efforts taken. Failure to satisfy this requirement to the satisfaction of the owner shall constitute a non-responsible bid and shall be cause for the owner to reject the bid.

(4). The contractor shall implement the specific six affirmative steps as provided in the Special Notice under the Instructions to Bidders section of these specifications.

(5). The contractor and all subcontractors must maintain documentation and records of all solicitations of offerers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations. Within 21 days of the determination of the apparent low bidder, the contractor must furnish to the Loan Recipient all pertinent documentation, which evidences or documents a good faith effort in MBE/WBE solicitation and projected utilization. Failure to comply with the submission of appropriate MBE/WBE documentation may result in the determination of a bidder as non-responsible and shall cause for the bid to be rejected.

(6). Immediately following the award of contracts and continuing through the constructions state, all records of MBE/WBE utilization shall be maintained and reported in accordance with the Department of Commerce Form SF-334. A MBE/WBE Utilization Report Form SF-334 shall be completed and submitted to the Loan Recipient on a calendar year quarterly basis during the construction period. Please see the attached Instruction to Bidders/Offerers for MBE/WBE Requirements.

**Instruction to Bidders/Offerers:
Minority Business and Women's Business Enterprise
(MBE/WBE) Requirements of 40 CFR 33.240**

Bidder/Offerer Responsibilities:

A. Affirmative Steps: Activities during preparation of bids and offers. Bidders/Offerers shall take affirmative steps in compliance with the regulations, prior to submission of bids or closing data for receipt of initial offers, to encourage participation in projects by MBEs and WBEs. Such efforts include:

(1). Establish and maintain a current solicitation list of minority and female recruitment sources, and assure MBEs and WBEs are solicited once they are identified.

(2). When feasible, segmenting total work requirements to permit maximum MBE/WBE participation and establish delivery schedules to encourage MBE/WBE participation.

(3). Assuring that MBEs and WBEs are solicited whenever they are potential sources of goods or services. This step may include:

a. Sending letters or making other personal contact with MBEs, WBEs, private agencies and state associations (e.g., those whose name appears on lists prepared by the recipient and other MBE/WBE known to the bidder/offerer). MBEs and WBEs should be contacted when other potential subcontractors are contacted, within reasonable time prior to bid submission or closing date for receipt of initial offers. Those letters or other contacts should communicate the following:

- (i) Specific description of the work to be contracted;
- (ii) How and where to obtain a copy of plans and specifications or other detailed information needed to prepare a detailed price quotation.
- (iii) Date the quotation is due to the bidder/offerer
- (iv) Name, address, and phone number of the person in the bidder/offerer's firm whom the prospective MBE/WBE subcontractor should contact for additional information.

b. Using the services and assistance of the Small Business Administration, the Office of Minority Business Enterprises of the U.S. Department of Commerce, or the list by DELDOT in Dover, DE.

- B. Bidders/Offerers must demonstrate compliance with MBE/WBE requirements to be deemed responsible. Demonstration of compliance may include the following information; however, the recipient may specify other methods of demonstrating compliance:
- (1). Names, addresses, and phone numbers of MBE/WBEs expected to perform work;
 - (2). Work to be performed by the MBEs and WBEs;
 - (3). Show dollar amount of work to be performed by MBEs and show dollar amount to WBEs separately.
 - (4). Description of contacts to MBE and WBE organizations, agencies, and associations which service MBEs/WBEs, including names of organizations, agencies, and associations and dates of contacts.
 - (5). Descriptions of contacts to MBEs and WBEs, including number of contacts, fields, (i.e., equipment or material supplier, excavators, transport services, electrical subcontractors, plumbers, etc.), and dates of contact.
- C. Successful bidders/offerers should take responsible affirmative steps to subcontract with MBEs and WBEs whenever additional subcontracting opportunities arise during the performance of the contract.

DRINKING WATER STATE REVOLVING FUND PROGRAM REQUIREMENTS

SPECIAL INSERT

For insertion into the Instructions for Bidders

This is to advise bidders of the requirements of this program regarding the “affirmative steps” necessary to be deemed a responsive and responsible bidder.

The Federal Register Part 40 CFR 33.240 requires these “affirmative steps” in procurement actions to assure that MBE and WBE firms are awarded a fair share of subagreements:

- (1). Including qualified small, minority, and women’s business solicitation lists.
- (2). Assuring that small, minority, and women’s businesses are solicited whenever they are potential sources.
- (3). Dividing total requirements, when economically feasible, into small tasks or quantities to permit maximum participation of small, minority, and women’s businesses.
- (4). Establishing delivery schedules, where the requirements of the work permit which will encourage participation by small minority and women’s businesses.
- (5). Using the services and assistance of the Small Business Administration and the Office of Minority Business Enterprise of the U.S. Department of Commerce.
- (6). Requiring each party to a subagreement to take the affirmative steps in 1 through 5 above.

DRINKING WATER STATE REVOLVING FUND PROGRAM REQUIREMENTS

PART E:

Civil Rights Act of 1964

The contractor and any subcontractors shall not, on the grounds of race, color, or national origin, or sex, exclude from participation in, deny the benefits of, or subject to discrimination, any person under any program or activity receiving Federal financial assistance.

PART F:

Section 13 of PL 92-500; Under the Federal Water Pollution Control Act; Rehabilitation Act of 1973; PL 93-112; And Age Discrimination Act of 1975

The contractor and any subcontractors shall not on the ground of race, color, national origin, or sex, exclude from participation in, deny the benefits of, or subject to discrimination any person or activity funded in whole or in part with Federal funds. Any prohibition against discrimination on the basis of age under the Age Discrimination Act of 1975, or with respect to any otherwise qualified handicapped individual as provided in Section 504 of the Rehabilitation Act of 1973 shall also apply to any such program of activity.

DRINKING WATER STATE REVOLVING FUND PROGRAM REQUIREMENTS

PART G: Compliance with Section 306 of the Clean Air Act and Section 508 of the Clean Water Act

(Contracts and Subcontracts in Excess of \$10,000)

The contractor agrees that:

- 1.) Any facility to be utilized in the performance of this contract or any subcontract shall not be a facility listed on the EPA List of Violating Facilities pursuant to 40 CFR 15.20.
- 2.) The contractor and subcontractors will comply with all requirements of Section 306 of the Clean Air Act, as amended, and Section 508 of the Clean Water Act, as amended, and all regulations and guidelines issued thereunder.

PART H: Suspension and Debarment and Other Responsibility Matters

The Project or Program to which the work covered by this contract pertains to is being assisted by the State of Delaware and the following provision is included in this Contract pursuant to the provisions applicable to such SRF Program. Loan Recipients or engineering representatives are to refer to the "List of parties exclude from Federal Procurement and Nonprocurement Programs" to insure that the contractor or subcontracts are not on this list. A copy of the list may be obtained from the world wide web at www.arnet.gov/epls or by calling (202) 512-1800 or by writing to this address:

Superintendent of Documents
U.S. Government Printing Office
Washington, DC
20402

DRINKING WATER STATE REVOLVING FUND PROGRAM REQUIREMENTS

PART I: PROJECT SIGN

- 1.) The contractor shall provide and erect a sign at a prominent location at each construction site. The sign and location shall be approved by the Engineer. The sign shall be prepared in accordance with the attached detailed instructions. It shall be the responsibility of the Contractor to maintain the sign in good condition throughout the life of the project.
- 2.) The sign wording shown on the attachment is for example only and must be adapted to suit each project. The Contractor shall be responsible for obtaining the appropriate wording from the Engineer.

PART J: ACCESS TO PROJECT SITE

- 1.) The Contractor shall allow representatives of U.S. EPA, and State of Delaware DHSS-ODW access to the project site.

ENSURING SAFE DRINKING WATER FOR ALL
DELAWAREANS

PROJECT TITLE
SECOND LINE IF NEEDED

FUNDING PROVIDED BY:
DRINKING WATER STATE REVOLVING FUND AND U.S.E.P.A.
AMOUNT \$
FUNDING RECIPIENT



- Sign Dimensions (4' X 8' X 3/4") Exterior Plywood (A-B Grade)
- Ensuring safe drinking water are 2.75 inches
- Project Title is 3.5 inches – Remaining lines are 2 inches
- Black letters on white background with three inch border around the perimeter in black
- Keep sign a proper distance above grade to permit public viewing and provide adequate support for sign
- DHSS logo stickers will be provided by the Office of Engineering

The Six Good Faith Efforts and Contract Administration Requirements

The Keys to Outreach and Opportunity

Program Comparison

Old MBE/WBE Program	New DBE Program
Following the “Six Affirmation Steps” under 40 CFR Part 31, and “Six Positive Efforts” under 40 CFR Part 30 were required by all grantees.	The “Six Good Faith Efforts” combine the “Six Affirmative Steps” and the “Six Positive Efforts” and are still required by all grantees. The substance of the efforts has not changed.
No protections for DBE Subcontractors	Several mechanisms are in place to protect DBE Subcontractors: <ul style="list-style-type: none"><li>• 30 day payment provision, notifications of DBE terminations, and continuing the Six Affirmative Steps after termination of DBE
No Mechanism for recipients to develop and maintain their own list of DBEs	Recipient’s are now required to create and maintain a bidders list. There is a \$250K exemption for this requirement.

What is the Purpose of the Six Good Faith Efforts?

The Good Faith Efforts are required methods implored by all EPA financial assistance agreement recipients to ensure that all disadvantaged business enterprises (DBEs) have the opportunity to compete for procurements funded by EPA financial assistance dollars.

What are the Six Good Faith Efforts?

- Ensure DBEs are made aware of contracting opportunities to the fullest extent practicable through outreach and recruitment activities. For Indian Tribal, State and Local, and Government recipients, this will include placing DBEs on solicitation lists and soliciting them whenever they are potential sources.
- Make information on forthcoming opportunities available to DBEs and 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. This includes, whenever possible, posting solicitations for bids or proposals for a minimum of 30 calendar days before the bid or proposal closing date.
- Encourage contracting with a consortium of DBEs when a contract is too large for one of these firms to handle individually.
- Consider in the contracting process whether firms competing for large contracts could subcontract with DBEs. For Indian Tribal, State and Local Government recipients, this will

include dividing total requirements when economically feasible into smaller tasks or quantities to permit maximum participation by DBEs in the competitive process.

- Use the services and assistance of SBA and the Minority Business Development Agency of the Department of Commerce.
- If the prime contractor awards subcontracts, require the prime contractor to take the steps in paragraphs (a) through (e) of this section.

What are The New Contract Administration Requirements?

There are a number of new provisions designed to prevent unfair practices that adversely affect DBEs. Those provisions are as follows:

- A recipient must require its prime contractor to pay its subcontractor for satisfactory performance no more than 30 days from the prime contractor's receipt of payment from the recipient.
- A recipient must be notified in writing by its prime contractor prior to any termination of a DBE subcontractor for convenience by the prime contractor.
- If a DBE subcontractor fails to complete work under subcontract for any reason, the recipient must require the prime contractor to employ the six good faith efforts if soliciting a replacement subcontractor.
- A recipient must require its prime contractor to employ the six good faith efforts even if the prime contractor has achieved its fair share objectives.

What is the New Bidders List Requirement?

The purpose of a bidders list is to provide the recipient and entities receiving identified loans who conduct competitive bidding with as accurate of a database as possible about the universe of MBE/WBE and non-MBE/WBE prime and subcontractors.

- A recipient of a Continuing Environmental Program Grant or other annual grant must create and maintain a bidders list.

- A recipient of an EPA financial assistance agreement to capitalize a revolving loan fund also must require entities receiving identified loans to create and maintain a bidders list if the recipient of the loan is subject to, or chooses to follow, competitive bidding requirements.
- The list must include all firms that bid or quote on prime contracts or bid or quote subcontracts on EPA assisted projects, including both MBE/WBEs and non-MBE/WBEs.
- The bidders list must only be kept until the grant project period has expired and the recipient is no longer receiving EPA funding under the grant. For entities receiving identified loans, the bidders list must only be kept until the project period for the identified loan has ended.

What Information Must Be Retained on the Bidders List?

- (1) Entity's name with point of contact;
- (2) Entity's mailing address, telephone number, and email address;
- (3) The procurement on which the entity bid or quoted, and when; and
- (4) Entity's status as an MBE/WBE or non-MBE/WBE.

What Are There Exemptions From The Bidders List Requirements?

- A recipient of an EPA financial assistance agreement in the amount of \$250,000 or less for any single assistance agreement, or of more than one financial assistance agreement with a combined total of \$250,000 or less in any one fiscal year, is exempt from the requirement to create and maintain a bidders list.
- A recipient under CWSRF, DWSRF, or BCRLF Program is not required to apply the bidders list requirement to an entity receiving an identified loan in an amount of \$250,000 or less, or to an entity receiving more than one identified loan with a combined total of \$250,000 or less in any one fiscal year.
- These exemptions are limited to the bidders list requirements only.

SECTION 01050

FIELD ENGINEERING AND SURVEYING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Provide field engineering and surveying services for stakeout of all project features and structures as indicated on the Drawings and specified herein.
- B. Identify project benchmarks.
- C. Provide information for Record Documents.

1.02 QUALITY CONTROL

- A. The Contractor shall employ a Professional Land Surveyor (Surveyor) registered in The State of Delaware and acceptable to Engineer. Surveyor shall establish all lines, elevations, reference marks, batterboards, etc., needed by the Contractor or Engineer during the progress of the Work, and from time to time to verify such marks by instrument or other appropriate means.
- B. The Engineer shall be permitted at all times to check the lines, elevations, reference marks, batterboards, etc., set by the Contractor, who will correct any errors in lines, elevations, reference marks, batterboards, etc., disclosed by such check. Such a check shall not be construed to be an approval of the Contractor's Work and shall not relieve or diminish in any way the responsibility of the Contractor for the accurate and satisfactory construction and completion of the entire Work of this Project.

1.03 FIELD CONDITIONS AND MEASUREMENTS

- A. The Contractor shall base all measurements, both horizontal and vertical, from established benchmarks. The Contractor shall be responsible for field verification of all dimensions and conditions at the job site.
- B. Should the Contractor discover any discrepancy between actual conditions and those indicated on the Drawings, which prevent the following of good practice or the intent of the Drawings and Specifications, he shall notify the Engineer, request clarification and instructions, and shall not proceed with his Work until he has received instructions from the Engineer; provided that such wait does not unduly delay the progress of the Work.
- C. No claims shall be made for extra payment or extensions of Contract completion time if the Contractor fails to notify the Engineer of any discrepancy before proceeding.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01340.
- B. Submit name, address, and telephone number of Surveyor to Engineer before starting Work.
- C. On request, submit documentation verifying accuracy of survey Work.
- D. Submit certificate signed by Surveyor, certifying that elevations and locations of improvements are in conformance, or non-conformance, with Contract Documents.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify location of survey control points prior to starting Work. Please reference Plan Sheet C-01 for control points. Promptly notify Engineer of any discrepancies.

END OF SECTION

SECTION 01200

PROJECT MEETINGS

PART 1 GENERAL

1.01 DESCRIPTION

- A. City or its Designee will schedule and administer pre-construction meeting, and other meetings throughout progress of the work.
- B. Representatives of contractors and subcontractors attending meeting shall be qualified to act on behalf of entity each represents.

1.02 PRE-CONSTRUCTION MEETING

- A. Schedule after award of the Contract prior to the issuance of the Notice to Proceed.
- B. Location: As announced.
- C. Attendance:
 - 1. Owner's Representative.
 - 2. Engineer and his professional consultants.
 - 3. Contractor's Superintendent.
 - 4. Major Subcontractors.
 - 5. Others as appropriate.

1.03 PROGRESS MEETINGS

- A. Schedule once per month or as necessary.

PART 2 PRODUCTS

Not Required.

PART 3 EXECUTION

Not Required.

END OF SECTION

SECTION 01310

PROGRESS SCHEDULES

PART 1 GENERAL

1.01 GENERAL

- A. Promptly after award of Contract, prepare and submit to the City or its Designee, an estimated construction progress schedule for the work, with subschedules of related activities which are essential to its progress.
- B. Submit revised progress schedules monthly as construction progresses.

1.02 FORM OF SCHEDULES

- A. Prepare schedules in form of a horizontal bar chart.
 - 1. Provide separate horizontal bar for each design and construction trade or operation.
 - 2. Horizontal time scale: Identify first work day of each week.
 - 3. Scale and spacing: Allow space for notations and future revisions.

1.03 CONTENT OF SCHEDULES

- A. Construction Progress Schedule:
 - 1. Show complete sequence of construction by activity.
 - 2. Show dates for beginning, and completion of, each major element of construction.

1.04 PROGRESS REVISIONS

- A. Indicate progress of each activity to date of submission.
- B. Show changes occurring since previous submission of schedule.
 - 1. Major changes in scope.
 - 2. Activities modified since previous submission.
 - 3. Revised projections of progress and completion.
 - 4. Other identifiable changes.

1.05 SUBMISSIONS

A. Submit initial schedules within 10 days of Notice to Proceed construction.

1. Engineer will review schedules and return review copy within 10 days after receipt.
2. If required, resubmit within 7 days after return of review copy.

B. Submit revised progress schedules with each application for payment.

1.06 DISTRIBUTION

A. Distribute copies of the reviewed schedules to:

1. Job site file.
2. Subcontractors.
3. Other concerned parties.

B. Instruct recipients to report promptly to Contractor, in writing, any problems anticipated by projections shown in the schedules.

PART 2 PRODUCTS

Not Required.

PART 3 EXECUTION

Not Required.

END OF SECTION

SECTION 01340

SUBMITTALS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Submittal procedures.
- B. Proposed Products List.
- C. Shop drawings.
- D. Product data.
- E. Operation and maintenance data
- F. Samples.
- G. Manufacturers' instructions.
- H. Manufacturers' certificates.

1.02 SUBMITTAL PROCEDURES

- A. Cover all submittals with transmittal forms. Sequentially number the transmittal forms. Resubmittals to have original number with an alphabetic suffix.
- B. Identify Project, Contractor, Subcontractor or supplier; pertinent Drawing sheet and detail number(s), and specification Section number, as appropriate.
- C. Apply Contractor's "approved" stamp, signed or initialed certifying that review, verification of Products required, field dimensions, adjacent construction Work, and coordination of information, are in accordance with the requirements of the Work and Contract Documents.
- D. Schedule submittals to expedite the Project, and deliver to City or its Designee. Coordinate submission of related items.
- E. Identify variations from Contract Documents, Product or system limitations which may be detrimental to successful performance of the completed Work shall be identified also.
- F. Provide space for Contractor and Engineer review stamps.
- G. Revise and resubmit submittals as required, identify all changes made since previous submittal.

- H. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

1.03 PROPOSED PRODUCTS LIST

- A. Within 15 days after date of Notice to Proceed, submit complete list of major products proposed for use, with name of manufacturer, trade name and model number for each product.
- B. For products specified only by reference standards give manufacturer, trade name, model or catalog designation, and reference standards.

1.04 SHOP DRAWINGS

- A. Submit the number of copies which the Contractor requires, plus three (3) copies which will be retained by the City or its Designee.
- B. Submit for approval completely dimensioned shop, layout or setting drawings and catalog cuts or other data as required to provide a complete description of system equipment.
- C. Submit completely dimensioned shop drawings certified for construction by the manufacturer and approved by the Contractor which includes in plan and cross section, location of electrical connections and characteristics; wiring diagrams; utility requirements as to types, sizes and locations; anchor bolt layout; details indicating construction and materials of construction; diameter of shafting; dimensions and rated horsepower of all motors; gear and bearing ratings; service factors and weights of principal parts and completely assembled equipment.

1.05 PRODUCT DATA

- A. Submit the number of copies which the Contractor requires, plus three (3) copies which will be retained by the City or its Designee.
- B. Mark each copy to identify applicable products, models, options and other data. Supplement manufacturer's standard data to provide information unique to this Project.
- C. Submit performance data including pump curves; equipment capacities, characteristics and limitations; materials of construction; finishes.

1.06 OPERATION AND MAINTENANCE DATA

- A. Submit two copies of operation and maintenance (O&M) data prepared by the manufacturer/supplier with Shop Drawings and/or Product Data.

- B. Submission and review of O&M data will be considered an integral part of furnishing and installation of equipment.
- C. One copy of the reviewed O&M data will be returned with reviewed Shop Drawings and/or Product Data. Contractor shall make any corrections or additions required and incorporate data into O&M manuals described in Section 01700.

1.07 SAMPLES

- A. When determined as appropriate by the Engineer, submit samples to illustrate functional and / or aesthetic characteristics of the Product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
- B. Submit samples of finishes, textures, and patterns for selection.
- C. Include identification on each sample, with full Project Information.
- D. Submit the number of samples specified in individual specification Sections.
- E. Reviewed samples which may be used in the Work are indicated in individual specification Sections.

1.08 MANUFACTURER'S INSTRUCTIONS

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

1.09 MANUFACTURER'S CERTIFICATES

- A. When specified in individual specification Sections, submit manufacturer's certificate to Engineer for review, in quantities specified for Product Data.
- B. Indicate if materials or Products conform to or exceed 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.

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

Not used

END OF SECTION

SECTION 01400

QUALITY CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Quality assurance and control of installation.
- B. References.
- C. Field samples.
- D. Inspection and testing laboratory services.
- E. Manufacturers' field services and reports.

1.02 QUALITY ASSURANCE/CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions and workmanship, to produce Work of specified quality.
- B. Comply fully with manufacturers' instructions, including each step in sequence.
- C. Should manufacturer's instruction conflict with Contract Documents, request clarification from Engineer before proceeding.
- D. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform work by persons qualified to produce workmanship of specified quality.
- F. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.
- G. Requirements of Regulatory Agencies: The construction requirements of State, County, or other political subdivision specifications exceeding the requirements of the codes, standards, and approving bodies referenced herein shall be met and complied with.

- H. Both the Underwriters' Laboratories (UL) Listings and Approvals and the National Electrical Manufacturers' Associations (NEMA) stamps or seals shall be evidence where applicable to electrical apparatus forming parts of the process or mechanical equipment.

1.03 REFERENCES

- A. Conform to reference standard by date of issue current on date for receiving bids.
- B. Should specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.
- C. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any referenced document.

1.04 FIELD SAMPLES

- A. Install field samples at the site as required by individual specification Sections for review.
- B. Acceptable samples represent a quality level for the Work.
- C. Where field sample is specified in individual Sections to be removed, clear area after field sample has been accepted by Engineer.

1.05 INSPECTION AND TESTING LABORATORY SERVICES

- A. Contractor shall employ services of an independent firm to perform inspection and testing. Contractor shall pay for services of that firm.
- B. The independent firm will perform inspections, tests, and other services specified in individual specification Sections and as required by the Engineer.
- C. Reports will be submitted by the independent firm to the City or its Designee indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.
- D. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools storage and assistance as requested.
 - 1. Notify City and independent firm 48 hours prior to expected time for operations requiring services.

2. Make arrangements with independent firm and pay for additional samples and tests required for Contractor's use.
- E. Retesting required because of non-conformance to specified requirement shall be performed by the same independent firm on instructions by the Engineer. Payment for retesting will be charged to the Contractor by deducting inspection or testing charges from the Contract Sum/Price.

1.06 MANUFACTURER'S FIELD SERVICES AND REPORTS

- A. Submit qualifications of observer to Engineer 14 days in advance of required observations. Observer subject to approval of Engineer.
- B. 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, start-up of equipment, test, adjust and balance of equipment, and return services as applicable, and to initiate instructions when necessary.
- C. Representatives are to report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.
- D. Submit report within 30 days of observation to Engineer for review.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

END OF SECTION

SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Temporary Utilities: Electricity, lighting, heat, telephone service, water, and sanitary facilities.
- B. Temporary Controls: Barriers, enclosures and fencing, protection of the Work, water control, and dust control.
- C. Construction Facilities: Access roads, parking, progress cleaning, noise control.

1.02 TEMPORARY ELECTRICITY

- A. Provide and pay for power service required from utility source.
- B. Provide temporary electric feeder and electrical service.
- C. Provide separate metering for cost of energy used.

1.03 TEMPORARY LIGHTING

- A. Provide and maintain lighting for construction operations.

1.04 TEMPORARY HEAT

- A. Provide heat devices and heat as required to maintain specified conditions for construction operations.

1.05 TELEPHONE SERVICE

- A. Provide, maintain and pay for telephone services as required.

1.06 TEMPORARY WATER SERVICE

- A. Provide, maintain and pay for suitable quality water service required for construction operations.
- B. Contractor shall not use potable water well or well pump to be provided as Work of this Contract as a source of temporary water service.

1.07 TEMPORARY SANITARY FACILITIES

- A. Provide and maintain required facilities and enclosures.

1.08 BARRIERS AND FENCING

- A. Provide barriers or fencing to protect existing facilities and adjacent properties from damage from Work operations.
- B. Provide protection for plant life designated to remain. Replace damaged plant life.
- C. Protect non-owned vehicular traffic, stored materials, site and structures from damage.

1.09 WATER CONTROL

- A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.
- B. Protect site from puddling or running water. Provide measures to protect site from soil erosion.

1.10 DUST CONTROL

- A. Provide all labor, equipment, machinery and other means to control dust emissions throughout the site for the duration of the project.
- B. Contractor shall abate dust nuisance by cleaning, sprinkling with water or other means as necessary.
- C. The use of water, in amounts which result in ponding, is not acceptable as a substitute for other methods.

1.11 PROTECTION OF INSTALLED WORK

- A. Protect installed Work and provide special protection where specified in individual Specification Sections.
- B. Provide temporary and removable protection for installed Products. Control activity in immediate Work area to minimize damage.
- C. Provide protective coverings at walls, projections, jambs, sills and soffits of openings.
- D. Protect finished floors, stairs and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

- E. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- F. Prohibit traffic on landscaped areas.

1.12 ACCESS ROADS

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

1.13 PARKING

- A. Arrange for temporary parking areas to accommodate construction personnel.
- B. When site space is not adequate, provide additional off-site parking approved by Owner and off-site landowner.

1.14 PROGRESS CLEANING

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition. Brush clean or wash roadway near construction entrance(s) regularly. Rock tire scrubbers that are part of E&S controls shall be cleaned by rock removal, and replaced regularly.
- B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces and other closed or remote spaces, prior to enclosing the space.
- C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.
- D. Remove waste materials, debris, and rubbish from site and dispose off-site at an acceptable location.
- E. Maintain dust free all construction areas and adjacent sites.

1.15 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary above grade or buried utilities, equipment, facilities, materials, prior to Final Application for Payment inspection.
- B. Clean and repair damage caused by installation or use of temporary Work.
- C. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

1.16 ENGINEER FIELD OFFICE

- A. In addition, Contractor shall furnish and maintain temporary field offices for the Engineer at designated locations at the site. The field office shall be a portable frame building, office trailer, or indoor facility, as approved, and shall provide not less than 400 square feet of floor space with an enclosed office room. The office shall be watertight and weatherproof, shall have screened windows and solid door with a lock and 2 keys. The office shall be provided with electrical and telephone services (as specified below), for the duration of the Contract, and shall have the necessary equipment to maintain a temperature of 72 degrees F under all conditions. The Contractor shall provide sanitary facilities. The office shall have linoleum or tile floor and shall be furnished with:

- 1 - 30-inch by 60-inch desk with drawers and chair
- 1 - 36-inch by 72-inch table
- 1 - 42-inch by 72-inch drafting table with stool
- 1 - 4-drawer file cabinet with lock and 2 sets of keys. Cabinets shall be fire resistant, meeting the requirements for "Filing Devices, Insulated (36E9) Class D Label" of UL Specifications.
- 8 - Office chairs
- 1 - 7-foot 3-inch by 3-foot steel utility shelving assembled.
- 1 - Metal plan rack (12 plans each) with bookshelf
- 1 - 4-foot by 6-foot bulletin board, mounted
- 1 - clothes rack
- 1 - first aid kit
- 2 - Fire extinguishers, non-toxic, dry chemical, meeting U.L. for Class A, B and C fires

- 3 - Steel wastepaper baskets
- 2 - Telephones (one incoming line)
- 1 - Fax machine with separate telephone line
- 1 - Telephone answering machine
- 1 - Bottled water dispenser
- 1 - Copy machine

B. The office shall be set up, equipped, and made ready for use prior to the beginning of other Work on the Project and shall remain for at least seven (7) days after final acceptance of the Work or until all field records pertinent to the Project have been completed. It shall be maintained in good condition and appearance by the Contractor for the duration of the Project and shall then be removed and disposed of by him and the site cleaned up and left in a neat and acceptable condition within fifteen (15) days after final use. The Engineer will not approve any payment requests until the Contractor has erected the field office and it has been approved by the Engineer.

C. Contractor shall provide specified telephone lines with local monthly services at no cost to owner or Engineer for duration of time described above. Contractor may submit to Engineer monthly itemized telephone charges for long distance telephone services made from field office. Engineer shall reimburse Contractor for long distance charges made by Owner or Engineer from field office.

1.17 NOISE CONTROL

A. Contractor shall be responsible for maintaining noise control measures which meet the requirements of local codes or regulations.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01600

MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Products.
- B. Transportation and handling.
- C. Storage and protection.
- D. Scheduling and coordination.
- E. Product options.
- F. Substitutions.
- G. Installation requirements.
- H. Equipment demonstration.
- I. Manufacturer's Representative.

1.02 PRODUCTS

- A. Products: Means new material, plant materials, components, equipment, fixtures, and systems forming the Work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components required for reuse.
- B. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.
- C. Provide interchangeable components of the same manufacturer for similar components.
- D. Products shall comply, where applicable, to Section 00740 American Iron and Steel Requirement of these Specifications.

1.03 TRANSPORTATION AND HANDLING

MATERIAL AND EQUIPMENT

01600-1

- A. Transport and handle products in accordance with supplier's or manufacturer's instructions.
- B. Promptly inspect shipments to assure that products comply with requirements, quantities are correct, and products are undamaged.
- C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.
- D. When unloading materials, equipment, and machinery, provide special lifting harness or apparatus as may be required by manufacturers.

1.04 STORAGE AND PROTECTION

- A. Store and protect products in accordance with supplier's or manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight, climate controlled enclosures.
- B. Provide off-site storage and protection when site does not permit on-site storage or protection.
- C. Cover products subject to deterioration with appropriate covering to prevent damage.
- D. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
- E. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage. When applicable, store plant materials to prevent excessive drying and exposure to harsh environmental conditions and to prevent damage to roots, limbs or foliage.
- F. Arrange storage of products to permit access for inspection. Periodically inspect to assure products are undamaged and are maintained under specified conditions.

1.05 SCHEDULING AND COORDINATION

- A. Coordinate the delivery and installation of equipment with the Work of other sections.
- B. Electrical interface: Install or mount, as work of the Contract, those electrical components or apparatus as required for the equipment specified in the Contract.
- C. Start-up and testing: Coordinate start-up and testing with work of other sections and ensure that required utilities and water supply are available.

1.06 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Products of manufacturers named and meeting specifications. No options or substitutions will be allowed.
- C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

1.07 SUBSTITUTIONS

- A. Instructions to Bidders specifies time restrictions for submitting requests for substitutions.
- B. After bidding, substitutions may be considered when a product becomes unavailable through no fault of the Contractor by following the procedure described in the following paragraphs.
- C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.
- D. A request constitutes a representation that the Contractor:
 - 1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
 - 2. Will provide the same warranty for the Substitution as for the specified product.
 - 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
 - 4. Waives claims for additional costs or time extension which may subsequently become apparent.
- E. Substitutions will not be considered when they are indicated or implied on product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.
- F. Substitution Submittal Procedure:

1. Submit three copies of request for Substitution for consideration. Limit each request to one proposed Substitution.
2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence.
3. Submit proposed cost savings (credit) if substitution is allowed.
4. The Engineer will notify Contractor, in writing, of decision to accept or reject request.

1.08 INSTALLATION REQUIREMENTS

- A. The Contractor shall check all dimensions indicated immediately after award of the Contract. Advise the Engineer promptly of any discrepancies or interferences and obtain such measurements and information as may be required to satisfactorily install the work.
- B. Before ordering any material or doing any work, the Contractor shall verify all measurements and elevations and shall be responsible for the correctness of same. Any difference which may be found between field measurements and elevations and those indicated shall be promptly submitted to the Engineer for adjustment and approval before proceeding with the work.
- C. Verify that site conditions are ready to receive the Work.
- D. The Contractor shall lay out work and establish heights and grades in strict accordance with the Drawings, the building and finished site grades, and shall be responsible for the accuracy of such layout.
- E. Verify that required utilities are available and of the correct characteristics.
- F. Align, level and adjust equipment for satisfactory operation: install so that connecting and disconnecting of piping and accessories can be done readily, and so that all parts are easily accessible for inspection, operation and maintenance.
- G. Material and equipment shall be installed in accordance with manufacturers' written instructions and recommendations.
- H. Furnish and apply any initial grease or oil recommended by manufacturer before start-up.

- I. Manufacturer's representative shall review equipment installation and provide written certification that equipment and its installation meet manufacturer's recommendations and comply with the Specifications.
- J. Contractor for General Construction shall coordinate installation of equipment. Separate Contractors shall cooperate with each other to provide complete installations of all materials and equipment.
- K. In the event that installation requirements need clarification as to Contract responsibility, City or its Designee shall be final judge in delineation of responsibility. In no case shall need for clarification result in extension of Contract time or change in Contract Price.

1.09 EQUIPMENT DEMONSTRATION

- A. Contractor shall furnish all labor, tools, materials, equipment, power, and water for all demonstration tests.
- B. Operation of equipment during all phases of demonstration prior to Final Acceptance by Owner and Engineer is the Contractor's complete responsibility.
- C. Notify Engineer and Owner seven days in advance of each test or demonstration.
- D. Initial equipment start-up: After manufacturer's representative has reviewed the installation of his equipment and found it acceptable, he shall place equipment in operation. He shall perform all tests necessary to ensure each item of equipment operates in accordance with the design intent and Specifications. At a minimum the following tests are required:
 - 1. Starting current
 - 2. Running current
 - 3. Pumped flow rate at several different dynamic head conditions (for pumps).
 - 4. Control system function test.
 - 5. Demonstration of accuracy of flow meters and gauges.
- E. Correction of deficiencies - All performance deficiencies, leaks, misalignments found during start-up shall be corrected at Contractor's expense. Correction may include replacement of defective equipment if Engineer so recommends. Correction must be performed and accepted by Engineer prior to demonstrations.
- F. Initial Mechanical Performance Test: When equipment has been started and tested by manufacturer's representative, all deficiencies have been corrected, and

equipment operates as specified, Contractor shall demonstrate tests described in 1.09 D. above and other appropriate function tests to the Engineer and Owner.

- G. System Mechanical Performance Demonstration: When individual items of equipment which are part of a system have been shown to operate satisfactorily to Owner and Engineer, Contractor shall operate all equipment together as a system using water as process flow. Contractor shall test all performance functions, all alternate and emergency operating procedures and all alarm conditions using actual or simulated conditions. Contractor shall coordinate demonstration to ensure all required manufacturer's representatives and subcontractors are present. Each manufacturer's representative shall ensure that his equipment is performing as intended. All deficiencies shall be corrected at Contractor's expense.
- H. Contractor shall propose demonstration procedure in writing three days in advance for Engineer's review. Demonstration shall include all performance functions both for individual equipment components and entire system, all alarm conditions and all alternate and emergency operating procedures. All portions of system shall be operating simultaneously. All equipment must be permanently installed with permanent utility supplies and connections before demonstration may be scheduled. Demonstration shall continue until a minimum of two hours has accumulated when entire system is operating according to design intent and as specified.
- I. Successful Demonstration: When all equipment components perform individually and as an integrated whole according to the design intent and as specified and all deficiencies have been permanently corrected, System Mechanical Performance Demonstration shall be considered successful.
- J. Repeat Demonstration: When defects are encountered, repeat Demonstration after corrective actions have been taken. Continue this process until no defects are encountered.
- K. Electrical Contractor shall be present for performance of Initial Mechanical Performance Tests and System Mechanical Performance Demonstration for each piece of equipment having electrical connections.

1.10 MANUFACTURER'S REPRESENTATIVE

- A. Provide services of a qualified equipment manufacturer's representative under Provisions of Section 01400 to review installation, perform pre-start-up checks, start-up, test, adjust, and demonstrate equipment and instruct Owner in operation and maintenance procedures.

- B. Instruction for Owner shall not be scheduled until System Mechanical Performance Demonstration has been successfully completed.
- C. Instruction for Owner shall include review of start-up, operation and shut down procedures, alternate modes of operation, anticipated adjustments, maintenance procedures and schedules, troubleshooting methods and manufacturer's operation and maintenance literature. Owner reserves right to videotape instruction sessions.
- D. Manufacturer's Representative shall certify in writing that installation is satisfactory and that equipment is operating as specified.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not used

END OF SECTION

SECTION 01700

CONTRACT CLOSE-OUT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Close-out procedures.
- B. Final cleaning.
- C. Adjusting.
- D. Project record documents.
- E. Operation and maintenance manuals.
- F. Warranties.
- G. Spare parts and maintenance materials.

1.02 CLOSE-OUT PROCEDURES

- A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's inspection.
- B. Provide submittals to Engineer or Owner that are required by governing or other authorities.
- C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due. Include all specified releases, guarantees, waivers and other documents.
- D. List of Incomplete Items (Punch List)
 - 1. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction
 - a) Organize items by major element.
 - b) Include the following information at the top of each page:

- Project name.
- Date.
- Name of Owner.
- Name of Contractor.
- Page number.

- c) Submit list of incomplete items in the following format:
- PDF electronic file. Owner will return annotated file.

E. Certificate of Release: From authorities having jurisdiction.

F. Certificate of Insurance: For continuing coverage.

1.03 FINAL CLEANING

A. Execute final cleaning prior to final inspection.

B. Clean interior of all manholes and vaults and assure flow channels are free of debris.

C. Clean, remount and calibrate flow meters.

D. Clean debris from adjacent drainage systems.

E. Clean site; sweep paved areas, rake clean landscaped surfaces.

F. Remove waste and surplus materials, rubbish, and construction facilities from the site.

1.04 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

1.05 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents and record actual revisions to the Work daily:

1. Contract Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other modifications to the Contract.

5. Reviewed shop drawings product data, and samples.
- B. Store Record Documents separate from documents used for construction.
 - C. Record information concurrent with construction progress and make available for City or its Designee review prior to each monthly payment.
 - D. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
 1. Manufacturer's name and product model and number or description.
 2. Product substitutions or alternates utilized.
 3. Changes made by Addenda and modifications.
 - E. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:
 1. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 2. Measured depths to foundations in relation to finish floors.
 3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the work.
 4. Field changes of dimension and detail.
 5. Details not on original Contract Drawings.
 - F. Delete Engineer title block and seal from all documents.
 - G. Submit documents to City or its Designee with Contractor's notification that project is Substantially Complete.

1.06 OPERATION AND MAINTENANCE MANUALS

- A. Manuals shall be bound 8-1/2 x 11 inch text pages in binders with durable covers.
- B. Prepare binder covers with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS", title of project.

- C. Internally subdivide the binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
- D. Contents: Prepare a Table of Contents.
- E. Part 1: Directory, listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors, and suppliers.
- F. Part 2: Operation and maintenance instructions. Provide instructions for all equipment and materials utilized in the project arranged by process flow. Identify names, addresses, and telephone numbers of Subcontractors and suppliers. Include the following for each item:
 - 1. Significant design criteria.
 - 2. Erection or installation instructions.
 - 3. Start-up procedures.
 - 4. Recommended and alternative operating procedures.
 - 5. Schedule of preventative maintenance requirements.
 - 6. Parts list for each component.
 - 7. Schedule of recommended spare parts to be stocked, complete with part number, inventory quantity and ordering information.
 - 8. Detailed maintenance procedures.
 - 9. Schedule of lubrication requirements.
 - 10. Corrected and approved control and wiring diagrams.
 - 11. Data sheet listing pertinent equipment or system information.
 - 12. Addresses and telephone numbers of the nearest sales and service representatives.
 - 13. Troubleshooting guide.

- G. Part 3: Project documents and certificates, including the following:
 - 1. Shop drawings and product data.
 - 2. Certificates.
 - 3. Photocopies of warranties.
- H. Submit one copy of completed volumes in final form prior to Contractor's notification that work is Substantially Complete. This copy will be returned with Engineer comments. Revise content of documents as required prior to final submittal.
- I. Submit three (3) final sets of volumes, revised, within ten days after Engineer returns comments.

1.07 WARRANTIES

- A. Provide duplicate copies.
- B. Execute and assemble documents from Subcontractors, suppliers, and manufacturers.
- C. Assemble in binder with durable cover.
- D. Submit with Operation and Maintenance Manuals.
- E. Provide starting and ending dates of warranty period.

1.08 SPARE PARTS AND MAINTENANCE MATERIALS

- A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual specification sections.
- B. Deliver and place in location as directed; obtain receipt prior to final payment.

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

Not used

END OF SECTION

SECTION 02060

DEMOLITION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Contractor shall provide all labor, materials, equipment and incidentals required for demolition work.
- B. Without intending to limit or restrict the extent of work required under contract, the work generally comprises of the removal, relocation and/or disposal of tanks, piping and valving, concrete pads and miscellaneous equipment as detailed on the Demolition Plan and other plans of the Contract Drawings. The work also requires plugging and capping of pipes, backfilling of abandoned structures and restoration.

1.02 SUBMITTALS

- A. Submit in accordance with Section 01340.
- B. Demolition Sequence: Indicate demolition, removal procedures, operational sequence, construction of barricades, fences and other temporary work.
- C. Permits and or notices required for demolition.
- D. Permits for transport and disposal of debris.

1.03 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01700.
- B. Accurately record actual locations of utilities, pipes subsurface foundations, and other obstructions that remain adjacent to demolition as required under provisions of Section 01700.

1.04 REGULATORY REQUIREMENTS

- A. Conform to applicable local, State and Federal codes and regulations for demolition work; safety of workers; dust and runoff control; and abandonment of sewer systems.
- B. Obtain all required permits and notices from authorities for all portions of the work.
- C. Use of explosives will not be permitted.

- D. Notify affected utility companies before starting work, and comply with their requirements.

1.05 SCHEDULING

- A. Schedule work under provisions of Section 01310.
- B. Describe demolition removal sequence and schedule for review by Engineer.
- C. Notify Engineer in writing seven days prior to commencement of demolition work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION AND PROTECTION

- A. Before beginning any cutting or demolition work, the Contractor shall carefully survey the existing work and examine the Drawings and Specifications to determine the extent of the Work. The Contractor shall take all necessary precautions to ensure against damage to existing work to remain in place and any damage to such work shall be repaired or replaced at no additional cost to the Owner. The Contractor shall carefully coordinate the work of this section with all other work and construct and maintain shoring, bracing, and supports, as required. The Contractor shall ensure that structural elements are not overloaded and be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under any part of this contract. Contractor shall protect all underground structures or existing utilities from damage by demolition work.
- B. Perform all demolition and removal Work to prevent damage to adjacent properties and areas and features not designated to be demolished. Any damage caused by Work shall be repaired at Contractor's expense.

3.02 GENERAL REQUIREMENTS

- A. Maintain operations for water production at all times during the demolition and/or relocation of existing equipment and controls. Contractor shall not re-direct flow until new facilities have been thoroughly tested and demonstrated they are capable of use as intended. Meetings with Owner and Engineer are required 7 days prior to removal of existing treatment components to best assure minimizing water production interruptions.
- B. If necessary, provide temporary facilities to maintain flow during construction of new facilities and demolition of old facilities.

- C. Conduct operations with minimum interference to roadways and other accesses adjacent to the Work. Maintain access and egress at all times. Closing or obstruction of accesses and fire hydrants will not be permitted without proper authorization.
- D. Obtain written permission from adjacent property owners when demolition and removal equipment will traverse, infringe upon, or limit access to their property.
- E. When underground piping is to be altered or removed, the remaining piping shall be properly capped and plugged with concrete.
- F. Arrange for, and verify termination of utility services.
- G. Equipment removed for Owner shall be cleaned and stored for the Owner upon removal. This equipment and/or materials are listed on the drawings.

END OF SECTION

SECTION 02100

SITE CLEARING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Remove surface debris.
- B. Remove paving, curbs, and/or other items necessary to complete the Work.
- C. Clear site of all vegetation as required for construction.
- D. Remove trees and shrubs.
- E. Remove root system of trees and shrubs.

1.02 REGULATORY REQUIREMENTS

- A. Conform to applicable codes for disposal of debris.
- B. Coordinate clearing work with utility companies.
- C. Conform to applicable Erosion and Sediment Control requirements.

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that existing plant life and features designated to remain are tagged or identified. Where items to remain are in conflict with the Work, the Contractor shall notify the Engineer before proceeding with the Work.

3.02 PROTECTION

- A. Protect utilities that remain, from damage.
- B. Protect trees, plant growth, and features designated to remain as final landscaping.
- C. Protect benchmarks and existing structures from damage or displacement.

3.03 CLEARING

- A. Clear areas required for access to site and execution of work.
- B. Remove paving and curbs as required to finish the Work.
- C. Remove trees and shrubs, stumps, root systems and surface rock.
- D. Clear undergrowth and deadwood without disturbing subsoil.

3.04 REMOVAL

- A. Remove debris, rock, and extracted plant life from site.

END OF SECTION

SECTION 02211

ROUGH GRADING

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Remove topsoil and stockpile for later reuse. Remove excess from site.
- B. Excavate subsoil and stockpile for later reuse. Remove excess from site.
- C. Grade and rough contour site.

1.02 PROJECT RECORD DOCUMENTS

- A. Accurately record location of utilities remaining, rerouted utilities, new utilities by horizontal dimensions, elevations or inverts, and slope gradients.

1.03 PROTECTION

- A. Protect trees, shrubs, lawns, and other features remaining as portion of final landscaping.
- B. Protect bench marks, existing structures, fences, roads, sidewalks, paving, and curbs if not to be removed.
- C. Protect above or below grade utilities which are to remain.
- D. Repair damage.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Topsoil: Excavated material, graded free of roots, rocks larger than one inch, subsoil, debris and large weeds.
- B. Subsoil: Excavated material, graded free of lumps larger than 6 inches, rocks larger than 3 inches and debris.

PART 3 EXECUTION

3.01 PREPARATION

- A. Identify required lines, levels, contours and datum.
- B. Identify known below grade utilities. Stake and flag locations.
- C. Identify and flag above grade utilities.
- D. Maintain and protect existing utilities remaining which pass through work area.
- E. Notify general utility number, 811, of proposed work.

3.02 TOPSOIL EXCAVATION

- A. Excavate topsoil from areas to be further excavated, re-landscaped, or re-graded and stockpile in area designated on site. Remove excess topsoil not being reused from site.
- B. Do not excavate wet topsoil.
- C. Stockpile topsoil and protect from erosion.

3.03 SUBSOIL EXCAVATION

- A. Excavate subsoil from areas to be re-landscaped or re-graded, marked areas and stockpile on site. Remove excess subsoil not being reused from site.
- B. When excavation through roots is necessary, perform work by hand and cut roots with a sharp ax.

3.04 TOLERANCES

- A. Top Surface of Subgrade: Plus or minus one inch.

END OF SECTION

SECTION 02222

EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Excavation for building foundations.
- B. Excavation for slabs-on-grade, paving, landscaping and utilities.
- C. Excavation for site structures.

1.02 FIELD MEASUREMENTS

- A. Verify that survey benchmark and intended elevations for the Work are as indicated.

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

3.01 PREPARATION

- A. Identify required lines, levels, contours and datum.

3.02 EXCAVATION

- A. Underpin adjacent structures which may be damaged by excavation work, including utilities and pipe chases.
- B. Excavate subsoil required to accommodate pipes, building foundations, slabs-on-grade, paving and site structures as shown on the Drawings.
- C. Comply with all Federal, State and local codes, permits and regulations.
- D. Excavation cut not to interfere with normal 45 degrees bearing splay of foundations or any other adjacent structures or utilities.
- E. Grade top perimeter of excavation to prevent surface water from draining into excavation.

- F. Hand trim excavation. Remove loose matter.
- G. Remove lumped subsoil, boulders and rock up to 1/2 cu. yd. measured by volume.
- H. Notify Engineer of unexpected subsurface conditions or utility damage.
- I. Correct unauthorized excavation at no extra cost to Owner.
- J. Correct areas over-excavated by error.
- K. Stockpile excavated material in area designated on-site and remove excess material not being reused from site.
- L. Excavations for structures shall be kept dewatered. Where pumping is required, a sufficient number of pumps of adequate size shall be employed to keep the excavations dry and free of water at all times during excavation, and until the foundation work is completed. Sumps shall be constructed where necessary. Water removed from excavations shall be disposed of in such a manner as to not cause injury to public health, private property, street surfaces, embankments or to any portion of the work completed or in progress.
- M. Support excavations with sheathing, shoring and bracing or with a "trench box" as required to comply with Federal and State laws and codes.
- N. Install adequate excavation supports to prevent ground movement or settlement to adjacent structures, pipelines or utilities. Damage due to settlement because of failure to provide support or through fault of the Contractor in any other manner, shall be repaired at the Contractor's expense.
- O. Withdraw excavation supports when work is complete.

3.03 FIELD QUALITY CONTROL

- A. Provide field testing of bearing surfaces under provisions of Section 01400.

3.04 PROTECTION

- A. Protect excavations by methods required to prevent cave-in or loose soil from falling into excavation.
- B. Protect bottom of excavations and soil adjacent to and beneath foundation, from freezing.

END OF SECTION

SECTION 02223

BACKFILLING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Building perimeter, trench and site structure backfilling to subgrade elevations.
- B. Site filling and backfilling.
- C. Fill under slabs-on-grade and paving.
- D. Consolidation and compaction.
- E. Fill for over-excavation.
- F. Pipe trench backfilling will also be performed under provisions of Section 15000 "Piping and Valving" and as indicated on the drawings.

1.02 RELATED SECTIONS

- A. Section 01340 - Submittals.

1.03 REFERENCES

- A. ANSI/ASTM D1556 - Test Method for Density of Soil in Place by the Sand-Cone Method.
- B. ANSI/ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb. (2.49 kg) Rammer and 12 inch (304.8 mm) Drop. (Standard Proctor)
- C. ANSI/ASTM D2922 - Test Methods for Density of Soil and Soil Aggregate in place by Nuclear Methods.
- D. AASHTO T88 - Modified; T89, Modified; T90 Modified; and T99, Method C Modified.
- E. Delaware Department of Transportation State Highway Administration Standard Specifications for Road and Bridge Construction, latest edition – August 2001.

PART 2 PRODUCTS

2.01 FILL MATERIALS

BACKFILLING

02223-1

- A. Course limestone meeting AASHTO #1 aggregate requirements as specified in AASHTO M43.
- B. Limestone gravel meeting AASHTO #57 or AASHTO #7 aggregate requirements as specified in AASHTO M43.
- C. Structural fill consisting of compacted dense graded aggregate base shall conform to ASTM D2940.
- D. Graded aggregate meeting the requirements for graded aggregate - subbase as specified in Delaware Department of Transportation State Highway Administration Standard Specifications for Road and Bridge Construction, latest edition – August 2001.
- E. Subsoil - Excavated subsoil free of lumps larger than six inch size, gravel larger than three inch size, debris, clay, organic, and frozen material.
- F. Concrete for backfill - Structural concrete with a 28 day compressive strength of 3,000 psi.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify fill materials to be reused are acceptable.
- B. Verify foundation perimeter drainage installation has been inspected.
- C. Verify underground tanks are anchored to their own foundation to avoid floatation after backfilling.

3.02 PREPARATION

- A. If the foundation bears on residual soils and during excavation isolated areas of hard rock are encountered which requires a hoe-ram, these areas should be excavated to at least six inches below the foundation bottom. Structural fill consisting of compacted dense graded aggregate base (DGAB) conforming to ASTM D2940 should be placed below the foundation in that area to prevent the development of isolated hard spots in the foundation.
- B. During construction, all foundation subgrades should be protected from disturbance, and concrete should be placed as soon as possible after excavation. Should the residual soil foundation bearing surface become disturbed, the loose material to be removed and replaced with structural fill. Should decomposed rock bearing surface become disturbed, the loose material should be removed and replaced with concrete. Mudmats may be used to protect the subgrades from disturbance.

- C. Cut out soft areas of subgrade not capable of in situ compaction. Backfill with AASHTO #57 or subsoil fill and compact to density equal to or greater than requirements for subsequent backfill materials.
- D. Prior to placement of aggregate base course material at paved areas, compact subsoil to 95 percent of its maximum dry density in accordance with ANSI/ASTM D698.

3.03 BACKFILLING FOR BUILDINGS AND SLABS ON GRADE

- A. Backfill areas to contours and elevations with AASHTO #7 or #57 as shown on drawings.
- B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.
- C. Place and compact fill material in continuous layers not exceeding eight inches compacted depth of each layer.
- D. Employ a placement method that does not disturb or damage foundation perimeter drainage, foundation damp proofing, protective covers or utilities in trenches.
- E. Backfill against supported structures or utilities.
- F. Backfill simultaneously on each side of unsupported structures or utilities.
- G. Make grade changes gradual. Blend slope into level areas.
- H. Remove surplus backfill materials from site.
- I. Leave fill material stockpile areas completely free of excess fill materials.

3.04 BACKFILLING FOR SITE FILLING AND PAVING

- A. Backfill areas to contours and elevations with unfrozen materials.
- B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.
- C. Place and compact fill material in continuous layers not exceeding eight inches compacted depth of each layer.
- D. Employ a placement method that does not disturb or damage foundation perimeter drainage, foundation dampproofing, protective covers or utilities in trenches.
- E. Maintain optimum moisture content of backfill materials to attain compaction density of 95% Standard Proctor (ANSI/ASTM D698).

- E. Backfill against supported structures or utilities.
- F. Backfill simultaneously on each side of unsupported structures or utilities.
- G. Make grade changes gradual. Blend slope into level areas.
- H. Remove surplus backfill materials from site.
- I. Leave fill material stockpile areas completely free of excess fill materials.

3.05 TOLERANCES

- A. Top Surface of Backfilling: Plus or minus one inch from required elevations.

3.06 FIELD QUALITY CONTROL

- A. Field testing will be performed under provisions of Section 01400.
- B. Compaction testing will be performed in accordance with ANSI/ASTM D1556, ANSI/ASTM D698, ANSI/ASTM D2992, and with Section 01400.
- C. Frequency of Tests: Provide one test on every 50 cubic yards of backfill. Engineer may call for additional compaction tests on any backfilled material. If the results show the work does not meet specified requirements, the test shall be at the Contractor's expense and the cost deducted from payments.
- D. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

3.07 PROTECTION OF FINISHED WORK

- A. Protect finished Work.

END OF SECTION

SECTION 02500

PAVING AND SURFACING

PART 1 GENERAL

1.01 WORK INCLUDES

- A. The Contractor shall install hot-mix, hot laid asphaltic concrete pavement and base courses in accordance with details provided on the Drawings and specifications.
- B. Work shall include all labor, materials and equipment necessary to perform all paving and surfacing where shown on the contract drawings. The type of material, thickness and typical sections shall be as shown on the Contract Drawings.

1.02 QUALITY ASSURANCE

- A. Perform work in accordance with Section 01400.
- B. Specifications: Delaware Department of Transportation (DelDOT) Specifications for Road and Bridge Construction, August 2001, latest edition.
- C. Source Quality Control: Maintain quality in products by using those of a qualified bituminous concrete producer having qualified plant operating personnel.
- D. Experience: The bituminous concrete producer shall be DelDOT approved and shall be a bulk producer regularly engaged in production of hot-mixed, hot-laid bituminous concrete conforming to the standards referenced herein.
- E. Workmen Qualifications: Provide workmen thoroughly trained and experienced in the skills required who understands the design and is completely familiar with the application of stone base and bituminous concrete paving work.

1.03 REFERENCE STANDARDS

- A. Delaware Department of Transportation (DelDOT) Specifications for Road and Bridge Construction, August 2001, latest edition.

1.04 JOB CONDITIONS

- A. Weather Limitations: Apply tack coats only when ambient temperature is above 40° F and rising, and when temperature has not been below 35° F for 12 hours immediately prior to application. Do not apply when base is wet or contains an excess of moisture.
- B. Construct asphaltic concrete surface course (wearing course) only when atmospheric temperature is above 40° F and when base is dry. Binder course may be placed when air temperature is above 35° F and rising.

- C. Grade Control: Establish and maintain required lines and elevations.

1.05 SUBMITTALS

- A. Submit work items for review in accordance with Section 01340.
- B. Mix designs for bituminous concrete shall be submitted in writing by the Contractor sufficiently in advance of paving operations to allow for review approval. The design information shall include the following:
 - 1. The use of which the material is proposed.
 - 2. The designation, source and anticipated gradation of each of the component aggregates.
 - 3. The estimated percentage of each aggregate required to yield the desired blend.
 - 4. The resulting percentage passing each sieve size stipulated by the appropriate band.
 - 5. The source of the asphalt material to be used.
- C. Delivery Tickets: Submit for each placed on the project.

PART 2 PRODUCTS

2.01 MATERIALS

- A. The asphalt for the plant mix shall comply with Delaware Department of Transportation (DelDOT) Specifications for Road and Bridge Construction, August 2001, latest edition. The asphalt material shall meet the requirements of Division 800. A certificate of compliance will be acceptable.
- B. The mineral aggregate for asphalt plant mix shall consist of coarse aggregate and fine aggregate. The coarse aggregate shall be sound, angular crushed stone, crushed gravel or crushed slag. Uncrushed coarse aggregate may be used in base course mixtures if the mixture meets all the design criteria. The fine aggregate shall be well graded, moderately sharp to sharp sands.
- C. The mineral aggregate and asphalt shall be combined in a mixing plant to meet the gradations for asphalt concrete base and surface, as specified by the Delaware Department of Transportation.

2.02 PAVEMENT MIXES

- A. Composition of Mixtures: Binder and wearing course mixture composition shall

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conform to the requirements of the above referenced specifications and the following.

1. The approved job-mix formula shall lie within the specification limits and be suitable for the layer thickness and other conditions prevailing. It shall not be changed after work has started without the approval of the Engineer.

PART 3 EXECUTION

3.01 GENERAL

- A. Construction requiring the removal and replacement of roads, driveways, parking areas, curb and gutter, walks and paved areas, and new paving shall be as required herein and shall meet the following jurisdictional requirements.
 1. Delaware Department of Transportation (DelDOT) Specifications for Road and Bridge Construction, August 2001, latest edition.

3.02 REMOVAL OF EXISTING PAVEMENT

- A. Cut existing pavement in advance of excavating to neat lines.
- B. Saw cut existing pavement to the full depth of paving. Remove transfer devices where they exist.
- C. For walkways and curb and gutter provide temporary facilities as directed by the Engineer.

3.03 USE OF STEEL PLATING

- A. Whenever steel plating is required or used during construction within a paved roadway, the following requirements shall apply:
 1. Notify Engineer at least 48 hours in advance of placing steel plates in roadway. Unless otherwise approved by the Engineer, steel plates shall be removed in not more than seven days.
 2. Provide steel plate warning signs to crossing vehicular traffic.
 3. Steel plates shall be at least one inch thick and large enough to allow a minimum of one foot of bearing on three sides of the excavation. Pin plates to prevent movement.
 4. Provide cold bituminous mix on all edges of the steel plate tapered from the height of the steel plate extending a minimum of one foot to the existing road surface.

6. If an emergency condition occurs due to the excavation and plate placement that the Owner's forces must correct, the Contractor will be charged for cost of the corrective measures required.
7. Steel plates are not permitted between October 31 and April 15, or as directed by the Delaware Department of Transportation (DelDOT).

3.04 PREPARATION AND PLACEMENT OF PAVEMENT

- A. All debris, vegetation, or other perishable materials shall be removed from the jobsite, except for trees and shrubs designated for preservation. The site to be paved shall be graded to the required section and all excess material removed from the location of the work. Material in soft spots shall be removed to the depth required to provide a firm foundation and shall be replaced with Type B Backfill material. The entire subgrade area shall be thoroughly compacted to minimum density of 95 percent of the maximum dry density as determined by the Standard Proctor. The surface of the subgrade after compaction shall be hard, uniform, smooth, and true to grade cross-section.
- B. Excavate, replace or adjust as required existing features to assure a smooth transition to proposed paving including but not limited to water valve boxes, manhole frames and covers, etc.
- C. A tack coat shall be applied on the subgrade and base course. The rate of application of the tack coat shall comply with Delaware Department of Transportation (DelDOT) Specifications for Road and Bridge Construction, August 2001, latest edition,
- D. The Contractor shall provide the necessary equipment, materials, and labor to complete the job acceptable to the owner.
- E. The contractor shall furnish for testing and analysis representative samples to the designated testing laboratory. All materials and applications shall comply with DELDOT Standards. The contractor shall provide certification that the material furnished is in accordance with the contract. Sampling and testing shall be in accordance with the latest revisions of the American Association of State Highway and Transportation Officials (ASSHTO) or the American Society for Testing Materials (ASTM). A certificate of compliance will be acceptable.
- F. The surface of the completed work when tested with a 10'-0" straight edge shall not have irregularities in excess of 1/4 inch.
- G. For all areas of more than 200 square yards asphalt base and surface courses shall be spread and struck off with a paving machine. Any irregularities in the surface of the pavement course shall be corrected directly behind the paving machine. Excess material forming high spots shall be removed with a shovel or a lute. Indented areas shall be filled with hot mix and smoothed with a lute or the edge of a shovel

being pulled over the surface. Casting of mix over such areas shall not be permitted.

- H. If it is impractical to use a paving machine or spread box in areas of less than 200 square yards, asphalt base and surface courses maybe spread and finished by hand. Wood or steel forms rigidly supported to assure correct grade and cross section maybe used. Placing by hand shall be performed carefully to avoid segregation of the mix. Broad casting of material shall not be permitted. Any lumps that do not break down readily shall be removed.
- I. Rolling shall start as soon as hot mix material can be compacted without displacement. Rolling shall continue until thoroughly compacted and all roller marks have disappeared.
- J. In areas too small for the roller a vibrating plate compactor or hand tamper shall be used to achieve thorough compaction.
- K. The contractor shall guarantee in writing the satisfactory performance of the completed pavement for a period of five (5) years.

3.05 FIELD QUALITY CONTROL

- A. Thickness: In-place compacted thickness will not be acceptable if exceeding allowable variation from required thickness:
 - 1. Base Course: 1/2", plus or minus.
 - 2. Surface Course: 1/4", plus or minus.
- B. Surface Smoothness: Test finished surface of each asphaltic concrete course for smoothness, using 10 foot straightedge applied parallel with, and at right angles to centerline of paved area. Surfaces will not be acceptable if exceeding following tolerances for smoothness:
 - 1. Base Course Surfaces: 1/4".
 - 2. Wearing Course Surface: 3/16".

3.06 PROTECTION

- A. Protect from damage and vehicular traffic until paving has cooled and attained its maximum degree of hardness.

END OF SECTION

SECTION 02936

SITE RESTORATION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. All disturbed areas shall be restored in accordance with this section.
- B. Preparation of subsoil.
- C. Placing topsoil.
- D. Fertilizing.
- E. Seeding.
- F. Mulching.

1.02 DEFINITIONS

- A. Noxious Weeds: Includes Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwork, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

1.03 REGULATORY REQUIREMENTS

- A. Conform to requirements of the latest edition of the Delaware Department of Transportation State Highway Administration Standard Specifications for Road and Bridge Construction, latest edition – August 2001.
- B. Comply with regulatory agencies for fertilizer and herbicide composition.
- C. Comply with requirements of the Kent County Conservation District.

1.04 QUALITY ASSURANCE

- A. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

1.05 SCHEDULING AND COORDINATION

- A. Coordinate Work of this Section with Work of other Sections.

- B. Schedule site restoration operations to minimize the time disturbed areas will be left exposed to erosion.

1.06 SUBMITTALS

- A. Submit under provisions of Section 01340.
- B. Product Data: Provide data on all seed mixes with certified statement of weight, composition, mixture, percentage of purity, and germination as verification that the proper materials and volumes have been used. Also provide data on all soil amendment materials, herbicides, or other chemicals to be used for Work of this Section.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and protect Products to site under provisions of Section 01600.
- B. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.
- C. Deliver fertilizer in original, unopened waterproof bags showing weight, chemical analysis, name of the manufacturer.

PART 2 PRODUCTS

2.01 SEED MIXTURE

- A. Permanent and temporary grass seed mixture shall be in accordance with Sediment and Erosion Control Notes on the Drawings.
- B. The date of the last germination of the seed shall be within a period of six months prior to commencement of planting operations. Seed shall be from same of previous year's crop; each variety of seed shall have a purity of not less than 85%, a percentage of germination not less than 90%, shall have a weed content of not more than 1% and contain no noxious weeds.

2.02 TOPSOIL

- A. Excavated material from site and free of roots, rocks larger than one inch, subsoil, debris, and weeds.

2.03 MULCHING AND BINDER

- A. Dry oat or wheat straw, free from weeds and foreign matter detrimental to plant life. Hay is not acceptable.

- B. Synthetic binder for mulch shall be non-asphaltic emulsion, Mulch Mate Super Tack or approved equal.

2.04 SOIL SUPPLEMENTS

- A. Add limestone and fertilizer in accordance with Sediment and Erosion Control Notes on the Drawings.

2.05 WATER

- A. Clean, fresh and free of substances or matter which could inhibit vigorous growth of grass.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify that subgrade is ready to receive the work of this Section.

3.02 PREPARATION OF SUBSOIL

- A. Prepare subsoil to eliminate uneven areas and low spots. Maintain lines, levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas.
- B. Remove foreign materials, weeds, and undesirable plants and their roots. Remove contaminated subsoil.
- C. Prepare subgrade to obtain satisfactory bond between subsoil and topsoil by scarifying subsoil to a depth of 3 inches where topsoil is to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil. This operation shall not be performed when subgrade is frozen, excessively wet or dry. Scarify immediately prior to topsoil placement.

3.03 PLACING TOPSOIL

- A. Spread topsoil to a minimum depth of 4 inches over area to be seeded. Rake until smooth.
- B. Place topsoil during dry weather and on dry, unfrozen subgrade.
- C. Remove vegetable matter and foreign non-organic material while spreading.
- D. Grade to eliminate rough, low, or soft areas, and to ensure positive drainage.

3.04 SOIL SUPPLEMENTS

- A. Apply limestone and fertilizer according to manufacturer's instructions, and E&S Drawings.
- B. Apply after smooth raking of topsoil and prior to roller compaction.
- C. Do not apply lime or fertilizer at same time or with same machine as will be used to apply seed.
- D. Mix thoroughly into upper 2 inches of topsoil.
- E. Lightly water to aid the dissipation of fertilizer.
- F. Any irregularities or depressions caused by liming or fertilizing operations shall be corrected prior to seeding.

3.05 SEEDING

- A. Apply seed at a rate of 3 lbs per 1000 square feet either by hydroseeding or mechanical spreading.
- B. If using mechanical spreading apply evenly in two intersecting directions. Rake in lightly.
- C. Do not seed area in excess of that which can be mulched on same day.
- D. Do not sow immediately following rain, when ground is too dry, or during windy periods.
- E. Roll seeded area with roller not exceeding 112 lbs.

3.06 MULCHING

- A. Immediately following seeding and compacting, apply mulch at 1-1/2 tons per acre for an approximate thickness of 2 inches.
- B. Apply mulch binder at a rate recommended by manufacturer immediately after placement of mulch.
- C. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.

3.07 MAINTENANCE

- A. Areas shall be mowed not less than once each 10 days to help prevent weeds from establishing.
- B. General restored areas shall be cut to a height no less than 2 1/2".

- C. Neatly trim edges and hand clip where necessary.
- D. Control growth of weeds. If necessary, apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.
- E. Reseed any areas which do not show even stand.
- F. Contractor shall water restored areas until Final Completion.

3.08 GUARANTEE PERIOD

- A. All restored areas shall be guaranteed by the Contractor for not less than one full year from the date of Final Completion.
- B. During first planting season after Final Completion, any restored areas not demonstrating satisfactory stands, as determined by the Engineer, shall be renovated, reseeded, and maintained by Contractor until satisfactory stands are attained at all restored areas.
- C. A satisfactory stand shall be defined as an even stand of grass, after cutting, at least 2 1/2" tall with at least 85% germination.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 WORK INCLUDES

- A. Extent of the work is indicated on drawings.
- B. Work of this section includes, but is not necessarily limited to, the following:
 - 1. Structural concrete.
 - 2. Concrete appurtenances such as equipment pads and entrance pads.
 - 3. Footings and slabs on grade.
 - 4. Concrete reinforcement and accessories.
 - 5. Vapor barrier under slabs on grade.
 - 6. Hardener/Sealer application.

1.02 CODES AND STANDARDS

- A. Except as modified by the requirements specified herein and/or the details on the Drawings, all Work included in this Section shall conform to the applicable provisions of the following codes and standards:
 - 1. ACI 211.1 - Recommended Practice for Selecting Proportions for Normal and Heavy Weight Concrete
 - 2. ASTM C260 - Air Entraining Admixture for Concrete
 - 3. ACI 301 - Specifications for Structural Concrete for Buildings. The Contractor shall have one copy of ACI 301 available for reference on the work site at all times.
 - 4. ANSI/ASTM A185 - Welded Steel Wire Fabric for Concrete Reinforcement
 - 5. ANSI/ASTM A497 - Welded Deformed Steel Wire Fabric for Concrete Reinforcement
 - 6. ASTM A615 - Deformed and Plain Billet-Steel for Concrete Reinforcement

7. ASTM C33 - Concrete Aggregates
8. ASTM C150 - Portland Cement
9. ASTM C330 - Lightweight Aggregate for Structural Concrete
10. ASTM C994 - Preformed Expansion Joint Filler for Concrete (Bituminous Type)
11. ACI-304 - Recommended Practice for Measuring, Mixing, and Placing Concrete
12. ACI-305 - Recommended Practice for Hot Weather Concreting
13. ACI-306 - Recommended Practice for Cold Weather Concreting
14. ACI-311 - Manual of Concrete Inspection
15. ACI-315 - Manual of Standard Practice for Detailing Reinforced Concrete
16. ACI-318 - Building Code Requirements for Reinforced Concrete
17. ASTM C94 - Ready Mixed Concrete
18. ASTM Standards C143, C31, C173, C231, C172 and C39
19. ACI-350 - Concrete Sanitary Engineering Structures
20. ASTM D2103 - Polyethylene Film and Sheeting

B. Definitions:

1. ACI - American Concrete Institute,
P. O. Box 19150, Detroit, Michigan 43219
2. ASTM - American Society for Testing Materials
3. CRSI - Concrete Reinforcing Steel Institute, "Manual of Standard Practice"
228 N. LaSalle Street, Chicago, IL 60601

1.03 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of the codes, specifications and standards listed in 1.02 (above), except where more stringent requirements are shown or specified.

- B. Concrete Testing Service: Contractor shall engage a testing laboratory approved by Engineer, to perform material evaluation tests and to design concrete mixes under provisions of Section 01400. Quality Control Testing requirements are described in Part 3 of this Specification.

1.04 SUBMITTALS

- A. Product Data:
 - 1. Proposed design mix.
 - 2. Submit data for materials indicated herein:
 - a. Admixtures: Provide manufacturer's written certification that chloride ions content complies with specified requirements.
 - b. Submit data for materials and accessories, including reinforcement and forming accessories, admixtures, patching compounds, joint systems, waterstop, curing compounds, dry-shake finish materials, expansion bolts, adhesive anchors, vapor barrier and grout.
- B. Shop Drawings: Reinforcement: Submit shop drawings for fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, diagrams of bent bars, and arrangement of concrete reinforcement.
- C. Laboratory Test Reports: Submit laboratory test reports as specified to Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Forms:
 - 1. Forms for Exposed Finish Concrete: Unless otherwise indicated, construct formwork for exposed concrete surfaces with plywood, metal, metal-framed plywood faced or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings. Provide form material system shown on drawings. Provide form material with sufficient thickness to withstand pressure of newly-placed concrete without bow of deflection.
 - 2. Forms for Unexposed Finish Concrete: Form concrete surfaces which will be unexposed in finished structure with plywood, lumber, metal or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.

3. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

B. Reinforcing Materials:

1. Reinforcing Bars: ASTM A615, Grade 60, deformed.
2. Welded Wire Fabric: ASTM A185, welded steel wire fabric.
 - a. The type of mesh shall be approved by the Engineer.
3. Supports for Reinforcement: Provide supports for reinforcement including boosters, chairs, spacers and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI specifications, unless otherwise acceptable.
 - a. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

C. Concrete Materials:

1. General: Calcium chloride or admixtures containing more than 0.1% chloride ions are not permitted.
2. Portland Cement: ASTM C150, Type II, for all environmental concrete. Other Portland Cement shall be ASTM C150, Type I, unless otherwise acceptable to Engineer. Use one (1) brand of cement throughout project.
3. Fly ash shall be Class F. Fly ash shall meet all specifications described in ASTM C 618. Use of granulated blast furnace slag, Class C fly ash, or other non-approved pozzolans is prohibited. Fly ash shall be limited to 20% of the cement plus pozzolan by weight.
4. Normal Weight Aggregates: ASTM C33, and as herein specified. Provide aggregates from a single source for exposed concrete. All aggregate materials shall be tested and certified to be non-reactive according to one of the following ASTM methods: C227, C289, C295, C586 or C1260. Maximum aggregate size shall comply with recommendations in ACI 350.
 - a. For exterior exposed surfaces, do not use fine or coarse aggregates containing spalling-causing deleterious substances.
5. Water: Potable
6. Air-Entraining Admixture: ASTM C260.

- a. Products: Subject to compliance with requirements, provide one of the following:

- "Sike Aer"; Sika Corp.
- "MB-VR or MB-AE"; Master Builders
- "Dorex AEA"; W.R. Grace
- "Edoco 2001 or 2002"; Edoco Technical Products

- 7. Water-Reducing Admixture: ASTM C 494, Type A and contain not more than 0.1% chloride ions.

- a. Subject to compliance with requirements, provide one of the following:

- "Eucon WR-75"; Euclid Chemical Co.
- "Pozzolith 344"; Master Builders
- "Plastocrete 160"; Sika Chemical Corp.
- "Chemtard"; Chem-Masters Corp.

- 8. High-Range Water-Reducing Admixture: ASTM C 494, Type F and G

- a. Products: Subject to compliance with requirements, provide one of the following:

- "Daracem 100"; W.R. Grace
- "Rheobuild 716I"; Master Builders
- "Rheobuild 1000"; Master Builders

- 9. Chemical admixtures shall not alter specification requirements as to 28-day compressive strength.

- 10. The use of all admixtures shall be in accordance with ACI 212.3, "Chemical Admixtures for Concrete."

D. Related Materials:

- 1. Chemical Hardener: Colorless aqueous solution containing a blend of magnesium fluosilicate and zinc fluosilicate combined with a wetting agent, containing not less than 2 lbs. of fluosilicates per gal.

- a. Products: Subject to compliance with requirements, provide one of the following:

- "Surfhard"; Euclid Chemical Co.
- "Lapidolith"; Sonneborn-Contech
- "Saniseal 100"; Master Builders

"Burk-O-Lith"; The Burke Co.
"Hornolith"; A.C. Horn

2. Moisture-Retaining Cover: One of the following, complying with ASTM C171

Waterproof paper
Polyethylene film
Polyethylene-coated burlap

2.02 PROPORTIONING AND DESIGN OF MIXES

A. Design Mixes:

1. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method is used, use an independent testing facility acceptable to Engineer for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing unless otherwise acceptable to Engineer.
2. Submit written reports to Engineer of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed by Engineer.
3. Design mixes to provide normal weight concrete with the following properties, as indicated on drawings and schedules:
 - a. 3000 psi 28-day compressive strength; W/C ratio, 0.55.
 - b. 4000 psi 28-day compressive strength; W/C ratio, 0.50.
 - c. For all environmental concrete; 5000 psi 28-day compressive strength; W/C ratio, 0.40. If a pozzolan is used in the concrete, the maximum water-cement plus pozzolan ratio should be 0.40.
4. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at not additional cost to Owner and as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in work.
5. All hardened concrete shall meet ASTM C 1202 requirements for low permeability.

B. Admixtures:

1. Use water-reducing admixture in concrete as required for placement and workability.
2. Use air-entraining admixture in exterior exposed concrete and all floor slabs, unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content within the tolerance of plus-or-minus 1% within the limits of 5% air.
3. Use admixtures for water-reducing and set-control in strict compliance with manufacturer's directions.

C. Mix Proportioning:

1. Water-Cement Ratio: Provide concrete for following conditions with maximum water-cement (WC) ratios as follows:
 - a. Subjected to freezing and thawing; WC 0.42.
 - b. Subjected to deicers and water and wastewater retaining structures and for all environmental concrete used; W/C ratio, 0.40. If a pozzolan is used in the concrete, the maximum water-cement plus pozzolan ratio should be 0.40.
2. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:
 - a. Slabs: Not more than 3".
 - b. Reinforced foundation systems: Not less than 1" and not more than 4".
 - c. Other concrete: Not more than 4".

2.03 CONCRETE MIXES

- A. Ready-Mix Concrete: Comply with requirements of ASTM C94, and as herein specified.
1. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C94 may be required.
 2. When air temperature is between 85°F (30° C) and 90°F (32° C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90°F (32° C), reduce mixing and delivery time to 60 minutes.

2.04 ACCESSORIES

- A. Waterstop: 6" x 3/8", ribbed with center bulb, PVC waterstop as manufactured by Vinylex Corporation, or approved equal. Splicing shall be heat fused per manufacturer's recommendations.
- B. Bentonite Water Stop: RX101 waterstop by Volclay or approved equal.
- C. Preformed Bituminous Joint Filler: Resilient, non-extruding type premolded bituminous impregnated fiberboard units complying with AASHTO-M-213, ASTM D-1751, Federal Specification HH-F-341F, Type 1.
- D. Rubber Joint Sealant: The sealant shall be a multipart chemically curing polyurethane sealant which meets or exceeds the curing requirements of Federal Specification TT-S-00227D, (1) Type I (flow type) and Type II (nonsag type), Class A, (compounds resistant to 50 percent total joint movement). The color shall be gray to match concrete.
 - 1. A primer shall be used as recommended by the sealant manufacturer. A bond breaker such as masking tape, polyethylene film, or backing rod as supplied by the manufacturer shall be used at the bottom of the joint.
 - 2. Multi-part, non-sag, urethane sealant. W.R. Meadows Dualthane, Percora Corp. Dynatrol II or approved equal.
- E. Concrete Joint Sealer, Poured Elastic Type
 - 1. Hot-poured joint sealer shall conform to AASHTO M 173. The joint sealer shall be composed of a resilient and adhesive compound capable of effectively sealing joints in concrete against the infiltration of moisture and foreign material throughout repeated cycles of expansion and contraction with temperature changes. The material shall be capable of being brought to a uniform pouring consistency for completely filling the joints.
 - 2. Overheating of some joint materials may cause inadequate performance. Temperature control and mechanical agitation devices are recommended.
- F. Expansion Bolts: Shall be as follows (bolts, washers, and nuts shall be made of 304L stainless steel unless noted otherwise):

<u>Trade Designation</u>	<u>Manufacturer</u>
Star Slugin	Star Expansion Co. Mountainville, NY 10953
Rawl Multi-Calk	The Rawplug Co. 224 Peterson Road New Rochelle, NY 10802
Kwik-Bolt	Hilti Fastening Systems

One Cummings Point Road
Stamford, CT 06904

Expansive Screw Anchor

Ackerman-Johnson Co.
99 Commercial Drive
Addison, IL 60101

Phillips Red Head Self
Drilling Concrete Anchor

Phillips Drill Co.
U.S. 12 and Liberty Trail
Michigan City, IN 46360

Wej-IT

Wej-IT Corporation
500 Alter Street
Broomfield, Co 80020

Cinch Expansion Anchor

Anchor Alloys, Inc.
966 Meeker Avenue
Brooklyn, NY 11222

- G. Adhesive Anchors System: Shall be as follows (bolts, washers, and nuts shall be made of 304L stainless steel unless noted otherwise):

Trade Designation

Manufacturer

Redi-Chem Concrete
Anchor System

Phillips Drill Co.
U.S. 12 and Liberty Trail
Michigan City, IN 46360

Rawl Chem-Stud
Anchor System

The Rawlplug Co.
224 Peterson Road
New Rochelle, NY 10802

HIT-HY 200 Adhesive
Anchor System

Hilti Fastening Systems
One Cummings Point Road
Stamford, CT 06904

- H. Vapor barrier: Polyethylene film 10 mm thick, lapped 12" at laps.
- I. Grout: Shall be nonshrink grout; Embeco No. 636 or Masterflow No. 713 as manufactured by Master Builder or an approved equal.
- J. Epoxy Grout: Sikadur 32, high-mod, high-strength epoxy bonding/grouting adhesive.

PART 3 EXECUTION

3.01 FORMS

- A. Design, erect, support, brace and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation and position.
- B. Design formwork to be readily removable without impact, shock or damage to cast-in-place concrete surfaces and adjacent materials.
- C. Construct forms to sizes, shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste.
- D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.
- E. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.
- F. Form Ties: Factory-fabricated, adjustable-length, removable or snapoff metal form ties, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal.
 - I. Unless otherwise indicated, provide ties so portion remaining within concrete after removal is 1" inside concrete and will not leave holes larger than 1" diameter in concrete surface.
- G. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.
- H. Cleaning and Tightening: Thoroughly clean forms and adjacent surface to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is placed. Retighten forms and bracing as required to eliminate mortar leaks and maintain proper alignment.

3.02 PLACING REINFORCEMENT

- A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.
- B. Before placing, clean surface to remove loose rust and mill scale, earth, ice and other materials which reduce or destroy bond with concrete.
- C. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.
- D. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.
- F. Reinforcement shall not be bent or straightened in a manner injurious to the material.
- G. Reinforcement shall be secured in position and reviewed by the Engineer before pouring concrete.

3.03 JOINTS

- A. Construction Joints: Locate and install construction joints as indicated.
- B. Provide keyways at least 1-1/2" deep in construction joints in walls, slabs and between walls and footings.
- C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints.
- D. Construction Joints in Slabs-on-Grade: Construct isolation joints in slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls and elsewhere as indicated.

3.04 INSTALLATION OF EMBEDDED ITEMS

- A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete.
 - 1. Use setting drawings, diagrams, instructions and directions provided by suppliers of items to be attached thereto.

- B. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units sufficiently strong to support types of screed strips by use of strike-off templates or accepted compacting type screeds.
- C. Pipe Sleeves: Where piping, as specified under Section 15000 and as shown on Drawings, is required to pass through concrete construction, furnish a sleeve in the concrete work.

3.05 PREPARATION OF FORM SURFACES

- A. Clean re-used forms of concrete matrix residue, repair and patch as required to return forms to acceptable surface condition.
- B. Coat contact surfaces of forms with a form-coating compound before reinforcement is placed.
 - 1. Thin form-coating compound only with thinning agent of type, and in amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come in contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.
 - 2. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.06 CONCRETE PLACEMENT

- A. Preplacement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.
- B. Coordinate the installation of joint materials and moisture barriers with placement of forms and reinforcing steel.
- C. General: Comply with ACI 304 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete", and as herein specified.
 - 1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which is hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.

- D. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
- E. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI recommended practices.
- F. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6" into preceding layer. Do not insert vibrators in lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.
- G. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
- H. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
- I. Bring slab surfaces to correct level with straightedge and strikeoff. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
- J. Maintain reinforcing in proper position during concrete placement operations.
- K. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.
- L. When air temperature has fallen to or is expected to fall below 40°F (4°C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50°F (10°C), and not more than 80°F (27°C) at point of placement.
- M. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
- N. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
- O. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F (32°C). Mixing water may be chilled or chopped ice may be used to

control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.

- P. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
 - I. Fog spray forms, reinforcing steel and subgrade just before concrete is placed.
- Q. Use water-reducing retarding admixture (Type D) when required by high temperatures, low humidity, or other adverse placing conditions.
- R. Concrete shall not be allowed to drop freely more than 4 feet, and the drop always shall be vertical. For greater drops, rubber or metal drop chutes shall be used.
- S. When concrete is conveyed by chutes, mechanical conveyors, or pumps, the equipment shall be of such size and design to insure continuous flow.

3.07 FINISH OF FORMED SURFACES

- A. Rough Form Finish: For formed concrete surfaces not exposed-to-view in the finish work or hidden by other construction, unless otherwise indicated. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched. Fins and other projections exceeding 1/4" in height, shall be rubbed down or chipped off.
- B. Smooth Form Finish: For formed concrete surfaces exposed-to-view, or that are to be covered with a coating material applied directly to concrete, such as waterproofing, dampproofing, painting or other similar system. Repair and patch defective areas. Fins or other projections shall be completely removed and smoothed.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.08 MONOLITHIC SLAB FINISHES

- A. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified.
 - I. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Check and level surface

plane, so that depressions between high spots do not exceed 5/16" under a 10' straightedge. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

- B. Non-Slip Broom Finish: Apply non-slip broom finish to exterior concrete slabs.
 - 1. Immediately after trowel finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.
- C. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and re-straighten until surface is free of trowel marks and uniform in texture and appearance.

3.09 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
 - 1. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.
 - 2. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.
- B. Curing Methods: Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing, and by combinations thereof, as herein specified.
 - 1. Provide moisture curing by following methods.
 - a. Keep concrete surface continuously wet by covering with water.
 - b. Continuous water-fog spray.
 - 2. Provide moisture-cover curing as follows:
 - a. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and end lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3. Provide curing and sealing compound to slabs, as follows:
 - a. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours). Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - b. Do not use membrane curing compounds on surfaces which are to be covered with coating material applied directly to concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring (such as ceramic or quarry tile, glue-down carpet), painting, and other coatings and finish materials, unless otherwise acceptable to Engineer.
4. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by application of appropriate curing method.
 - a. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise directed.
5. Sealer and Dustproofers: Apply a second coat of specified curing and sealing compound only to surfaces given a first coat.

3.10 REMOVAL OF FORMS

- A. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50°F (10°C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

3.11 RE-USE OF FORMS

- A. Clean and repair surfaces of forms to be re-used in work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form coating compound as specified for new formwork.
- B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to Engineer.

3.12 MISCELLANEOUS CONCRETE ITEMS

CAST-IN-PLACE CONCRETE

03300-16

- A. Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.
- B. Reinforced Masonry: Provide concrete grout for reinforced masonry lintels and bond beams where indicated on drawings and as scheduled. Maintain accurate location of reinforcing steel during concrete placement.

3.13 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Engineer.
 - 1. Cut out honeycomb, rock pockets, voids over 1/4" in any dimension, and holes left by tie rods and bolts, down to solid concrete but, in no case to a depth of less than 1". Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water and brush-coat the area to be patched with specified bonding agent. Place patching mortar after bonding compound has dried.
- B. For exposed-to-view surfaces, blend white portland cement and standard portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
- C. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Engineer. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets; fins and other projections on surface; and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes, fill with dry pack mortar, or precast cement cone plugs secured in place with bonding agent.
- D. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.
- E. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plan to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having required slope.
- F. Repair finished unformed surfaces that contain defects which affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01" wide or which penetrate to reinforcement or completely through non-reinforced sections

regardless of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions.

- G. Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days.
- H. Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operation by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to Engineer.
- I. Repair defective areas, except random cracks and single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4" clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
- J. Repair isolated random cracks and single holes not over 1" in diameter by dry-pack method. Groove top of cracks and cut-out holes to sound concrete and clean of dust, dirt and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of one part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry pack after bonding compound has dried. Compact drypack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.
- K. Perform structural repairs with prior approval of Engineer for method and procedure, using specified epoxy adhesive and mortar.
- L. Repair methods not specified above may be used, subject to acceptance of Engineer.

3.14 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. The Contractor shall employ a testing laboratory to perform tests and to submit test reports under the provisions of Section 01400.
- B. Sampling and testing for quality control during placement of concrete shall include the following, as directed by Engineer.
- C. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
 - l. Slump: ASTM C143; one test at point of discharge for the first batch of concrete each day, additional tests when concrete consistency seems to have

changed. Test before and after the authorized addition of mix water. One test for each set of compressive strength test specimens.

2. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C231 pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete, and one test for each set of compressive strength test specimens.
 3. Concrete Temperature: ASTM C1064, Test hourly when air temperature is 40°F (4°C) and below, and when 80°F (27°C) and above; each time a set of compressive strength test specimens are made and after authorized addition of mix water.
 4. Compressive Strength Tests: ASTM C 31; one set of four standard cylinders for each day's pour plus additional sets for each 25 cu. yds. over and above the first 50 cu. yds. of each concrete class placed in any one day; two specimens tested at 7 days, two specimens tested at 28 days.
 - a. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength tests meet or exceed the requirements of ACI 214 "Recommended Practice for Evaluation of Strength Test Results of Concrete", and ACI 318.
 - b. Mold and store cylinders for laboratory cured test specimens except when field cure test specimens are required.
- D. Test results will be reported in writing to Engineer and Contractor within 24 hours that tests are made. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
- F. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Engineer. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable concrete is verified.
- G. Leak Testing:
1. Follow requirements of Section 03501.

END OF SECTION

SECTION 03400

PRE-CAST CONCRETE STRUCTURES

PART 1 GENERAL

1.01 WORK INCLUDES

- A. Precast concrete structures.

1.02 REFERENCES

- A. ACI 301 - Structural Concrete for Buildings.
- B. ACI 318 - Building Code Requirements for Reinforced Concrete.
- C. ACI 350 R - Concrete Sanitary Engineering Structures.
- D. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- E. ASTM A307 - Specification for Low-Carbon Steel Externally and Internally Threaded Standard Fasteners.
- F. ASTM A325 - Specification for High Strength Bolts for Structural Steel Joints, Including Suitable Nuts and Plain Hardened Washers.
- G. ASTM A615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- H. ASTM C33 - Concrete Aggregates.
- I. ASTM C150 - Portland Cement.
- J. ASTM C260 - Air Entraining Admixtures for Concrete.
- K. ASTM C330 - Lightweight Aggregates for Structure Concrete.
- L. ASTM C494 - Chemical Admixtures for Concrete.
- M. PCI MNL-116 - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.
- N. PCI MNL-120 - Design Handbook - Precast and Prestressed Concrete.

- O. PCI MNL-123 - Manual on Design of Connections for Precast Prestressed Concrete.
- P. PCI MNL-127 - Manual on Recommended Practice for Erection of Precast Concrete.
- Q. Concrete Reinforcing Steel Institute, "Manual of Standard Practice."
- R. The most stringent code shall govern.

1.03 QUALITY ASSURANCE

- A. Testing:
 - 1. Certification from independent testing agency supplied by the manufacturer.
 - 2. Cost of Testing: Borne by Contractor.
- B. Codes and Standards:
 - 1. Except as modified by the requirements specified herein and/or the details shown on the Project Drawings, all work included in this section shall conform to the applicable provisions of the following codes and standards:
 - a. ACI 301
 - b. ACI 318
 - c. PCI MNL-116
 - d. PCI MNL-120
 - e. PCI MNL-123
 - f. Concrete Reinforcing Steel Institute, "Manual of Standard Practice".

1.04 STRUCTURAL DESIGN REQUIREMENTS

- A. The Contractor shall address all anticipated loading conditions as indicated on the Drawings, as specified herein, and as required by local and state building codes. All load cases shall be considered and the design shall be based on the governing cases which produce the greatest stresses on the structure. Load cases to be addressed include either or both of the following cases: tanks empty with saturated soil outside,

tanks full with saturated soil outside, tanks full with dry soil outside and tanks full with no soil pressure outside.

- B. Maximum ground water elevation shall be assumed to be at finish grade level. Saturated soil shall be assumed to exert a minimum equivalent fluid pressure of 90 p.c.f. onto the structure.
- C. All structures shall be designed to resist buoyancy when empty.
- D. Effects of all vertical, horizontal and lifting loads anticipated on the finished structure shall be included in the analysis and design. Loading from piping and equipment, snow, and adjacent H-20 live load shall be included.
- E. All structures shall be watertight.
- F. Where conditions arise which are not specifically covered by these notes and specifications, the Current Standards of ACI 301, 304, 306, 311, 315, 318, 350, and ASTM C-94, C890, C913 shall govern.
- G. Design calculations for the above conditions shall be prepared, signed and sealed by a Registered Professional Engineer, registered in the state where the Contract is performed and submitted to the Engineer for review.

1.05 SUBMITTALS

- A. Submit shop drawings under provisions of Section 01340.
- B. Submit design calculations and shop drawings indicating fabrication details, reinforcement, connection details, support items, member cross-sections and dimensions, gaskets, openings, manhole steps, size and type of reinforcement and lifting devices which shall be signed and sealed by a Professional Engineer licensed in the state where the Contract is performed.
- C. Indicate design loads, deflections, cambers, bearing requirements, and special conditions.
- D. Submit product data under provisions of Section 01340.
- E. Submit product data indicating standard component configurations, design loads, deflections, cambers, and bearing requirements.
- F. Submit data on proposed use of any admixture under provisions of Section 01340.

- G. Submit fabricator's installation instructions under provisions of Section 01340.
- H. Submit design data under provisions of Section 01340.
- I. Submit design data reports indicating calculations for loadings and stresses of fabricated, designed framing.

1.06 QUALIFICATIONS

- A. Fabricator: Company specializing in manufacturing the work of this Section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site at such times to assure continuity of installation.
- B. Handle precast members in position consistent with their shape and design. Lift and support only from support points.
- C. Lifting or Handling Devices: Capable of supporting member in positions anticipated during manufacture, storage transportation, erection.
- D. Store and protect members to prevent staining, cracking, chipping, spalling, or other physical damage of concrete.
- E. Mark each member with date of production and final position in structure.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

- A. Water: Clean and free of organic materials, strong acids or alkalis, oils and salt. Potable.
- B. Portland Cement ASTM-C150, Type I or Type III American manufacture. One (1) brand used throughout project.
- C. Sand: (Fine aggregate) shall be clean, sharp, coarse, (minimum fines) hard, natural sand free from salt, loam, clay and other deleterious materials and shall conform to ASTM Specification C33 or C330.

- D. Coarse Aggregate: Shall be well graded, washed gravel or crushed stone and shall conform to ASTM Specification C33 for normal weight aggregate.
- E. Admixtures: Determined by precast fabricator as appropriate to design requirements and conforming to ASTM Specification C494.

2.02 REINFORCEMENT

- A. Reinforcing Steel: Reinforcing bars shall be deformed high strength bars conforming to ASTM A615, Grade 40 or 60.
- B. Welded Wire Fabric: Fabric shall conform to ASTM A185.

2.03 FORMWORK

- A. Forms: Wood, metal, plastic, or other acceptable material that will produce required finish surfaces and is non-reactive with concrete.
- B. Maintain formwork to provide completed precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified in PCI MNL-116.
- C. Metal tie rods used to attach forms to concrete must be snapped off to 1-1/2 inch from the face of the concrete and patched with non-shrink grout.

2.04 ACCESSORIES

- A. Grout: Non-shrink, non-metallic, pre-mixed, non-corrosive, non-staining product containing selected silica sands, portland cement, shrinkage compensating agents, plasticizing and water reducing agents. Minimum yield strength of 10,000 psi at 28 days.
- B. High Strength Threaded Fasteners: Heavy hexagon structural bolts, heavy bolts, and hardened washers complying with ASTM A325. Exposed units galvanized per ASTM A153; others painted with rust-inhibitive primer.
- C. Anchor Bolts, Nuts and Washers: Low-carbon steel bolts, regular hexagon nuts and carbon steel washers conforming to ASTM A307. Exposed units galvanized per ASTM A153; others painted with rust-inhibitive primer.
- D. Supports for Reinforcement: Provide bolsters, chairs, spacers, and other devices for spacing, supporting and fastening reinforcing in accordance with CRSI and ACI recommendations.

- E. Gaskets: Pipe penetrations in precast structures shall be constructed with integrally cast rubber or neoprene gaskets unless otherwise indicated. Integrally cast gaskets shall be Dura Seal III, A-lok, Dual Seal or equal.
- F. Wall sleeves: Where indicated on the Drawings, precast structures shall have integrally cast mechanical joint wall sleeves. Integrally cast wall sleeves shall be cast iron Clow F-1429, Omni-Sleeve, or equal.
- G. Plastic coated steel steps equal to: manhole steps made by M.A. Industries, Inc. Peachtree City, GA.
- H. All steps shall be capable of resisting the following loads without loosening or damage.
 - 1. Minimum horizontal pull out load 400 lb.
 - 2. Minimum vertical load 800 lb.
- I. Joint Sealant: Watertight sealant shall be installed between all precast sections on both the interior and exterior edges of the joint. Ramsneck mastic tape or equal.

2.05 FABRICATION

- A. Fabrication procedure to conform to PCI MNL-116.
- B. Maintain plant records and quality control program during production of precast members. Make records available upon request.
- C. Reinforcing steel surface shall be free of rust, mill scale and any coating including ice that could destroy or reduce bond.
- D. Ensure reinforcing steel, anchors, inserts, plates, angles, and other cast-in items are embedded and located as indicated on shop drawings. Locate anchors where they do not affect position of main reinforcement or placing of concrete.
- E. Tension reinforcement tendons as required to achieve design load criteria.
- F. Cast-in required openings with a dimension larger than 6 inches or where indicated on Drawings.
- G. Concrete Strength: Minimum ultimate compressive strength of the concrete at age 28 days shall be 5000 psi. Slump shall not exceed 4 inches.

2.06 FINISHING

- A. Ensure exposed-to-view finish surfaces of precast concrete members are uniform in color and appearance.
- B. Cure members under identical conditions to develop required concrete quality, and minimize appearance blemishes such as non-uniformity, staining, or surface cracking.
- C. Interior and exterior above grade surfaces - Exposed-to-View Finish: Normal plant finish with fins and protrusions removed, ground edges and ends, and flat face surfaces.
- D. Exterior below grade surfaces - Normal plant finish; normal form joint marks, small surface holes caused by air bubbles, minor chips, and spalling at edges or ends, without major discoloration will be tolerated, but no major or unsightly imperfections, honeycomb or structural defects will be permitted.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that site conditions are ready to receive work and field measurements are as on Drawings.
- B. Ensure excavation is free of water and precast units will not be placed on frozen or soft ground.
- C. Beginning of installation means installer accepts existing conditions.

3.02 PREPARATION

- A. Prepare support equipment for the erection procedure, temporary shoring and bracing, and induced loads during erection.

3.03 INSTALLATION

- A. Install precast units according to manufacturer's recommendations and the Drawings without damage to structural capacity, shape, or finish. Replace or repair damaged members.
- B. Align and maintain uniform horizontal and vertical joints, as erection progresses.

- C. Maintain temporary bracing in place until final support is provided. Protect members from staining.
- D. Grout open spaces at connections and joints. Provide forms or other acceptable method to retain grout in place until sufficiently hard to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, plumb and level with adjacent concrete surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it hardens.
- E. Do not use power-actuated fasteners for surface attachment of accessory items in precast, prestressed unit unless otherwise accepted by precast manufacturer.

3.04 ERECTION TOLERANCES

- A. Erect members level and plumb.
- B. Conform to PCI MNL-127.

END OF SECTION

SECTION 03480

PRECAST POST-TENSIONED CONCRETE TANKS (OPTION)

PART 1 GENERAL

1.01 WORK INCLUDES

- A. Pre-Cast Post-Tensioned Tanks.

1.02 QUALITY ASSURANCE

- A. The tank shall be designed, fabricated, and erected by a firm having a minimum of 15 years experience in the manufacturing of tanks of a similar rectangular arrangement, using a precast post-tensioned design. The manufacturer shall document the installation of a minimum of thirty (30) such functioning facilities. All cast in place and precast concrete shall comply with the latest provisions of the following codes, specifications, and standards with all codes referenced therein, except where more stringent requirements are shown or specified.
- B. References
 - 1. ACI 318
 - 2. PTI Manual
- C. All post-tensioning shall be performed by PTI certified personnel.

1.03 DESCRIPTION OF WORK

- A. This work consists of furnishing and installing two complete precast post-tensioned concrete structures as described in the following specifications, and as shown on the Contract Drawings. The tanks shall rest on a pour-in-place slab. The tanks shall be manufactured, installed and assembled by one manufacturer. The contractor shall be responsible for any incidental cost incurred for installation of structures of a size or type other than indicated on the Contract Drawings; including but not limited to engineering, piping, excavation and backfill, electrical work, etc. and shall include all such incidental costs in his bid.
- B. The structure shall be precast post-tensioned concrete, as manufactured by Dutchland, Inc. located in Gap, PA or equal.

1.04 SUBMITTALS

- A. Structural Drawings: Detailed drawing and product submittals for the tank and accessories shall be submitted to the Engineer for approval prior to the fabrication or erection.

- B. Design Computations: Design computations for the tank foundations, walls, and beams, shall be submitted to the Engineer for review. The design computations shall be signed and sealed by a registered Professional Engineer licensed to practice in the State of Delaware. The Engineer's review does not in any way relieve the Contractor of his responsibility for the accuracy and completeness of his design.

1.05 WARRANTY

- A. The tank manufacturer shall provide a 10-year structural warranty to the Owner. The Manufacturer shall warrant that all items provided by the Manufacturer including the base, walls, walkways, etc. shall be free from material defect due to faulty equipment design, workmanship, or materials which appear, are discovered, and are reported in writing to the Manufacturer within 10-years of the installation date. This warranty shall also extend to maintenance items (i.e. tank coatings, etc.) provided and installed by the Manufacturer. If material defects due to faulty equipment design, workmanship, or materials are reported to the Manufacturer within a 10-year period, the Manufacturer shall furnish without charge to the Owner all necessary labor and materials required to repair all defects subject to this warranty. Such intended use is exemplified by the criteria of design, workmanship, and material expressed by the requirements of the Specifications and Drawings prepared by the Engineer. The warranty shall not be prorated.

PART 2 DESIGN

2.01 DESIGN CRITERIA

- A. Yield strength of reinforcement shall be 60,000 psi.
- B. Permissible tensile stress of reinforcement at service load shall be 22,000 psi per ACI350R-06.
- C. Modulus of elasticity of reinforcement shall be 29,000,000 psi.
- D. Compressive strength of precast concrete at 28 days shall be 5,000 psi.
- E. Compressive strength of poured-in-place concrete shall be 4,000 psi.
- F. Compressive strength of precast concrete at initial shall be 3,000 psi.
- G. Permissible stress of precast concrete at 28 days shall be 2,250 psi per ACI 350R-06.
- H. Weight of concrete shall be 150 pcf.
- I. Wind load shall be per ASCE 7-10.
- J. Lateral liquid, soil and wind pressure shall be 1.7 per ACI 350R-06.

- K. Load factor....product handling shall be 1.5 per PCI-1992 (table 5.2.1).
- L. Sanitary durability coefficient for environmental concrete structures shall be 1.3 per ACI 350R.
- M. At rest soil pressure coefficient shall be per the geotechnical report.
- N. Strength reduction factor for flexure shall be 0.90 per ACI 318-11.
- O. Strength reduction factor for shear shall be 0.85 per ACI 318-11.
- P. Time dependent factor for a sustained load (for 5 years or more) shall be 2 per ACI 318-11.
- Q. ZMax shall be 115 kips/in. per ACI 350.
- R. Allowable deflection shall be 180 per ACI 318-11.
- S. Safety factor (buoyancy) shall be 1.25.
- T. Seismic design shall be per ACI 350-01.3.
- U. Unit weight of sludge shall be 65.0 pcf per ACI 350.
- V. Unit weight of water shall be 62.4 pcf.
- W. Unit weight of soil shall be per geotechnical report.
- X. Tank shall be designed for the following load combinations:
 - 1. Tank full with no offsetting lateral soil pressure.
 - 2. Tank empty with soil to specified grade and wind applied to exposed portion.
 - 3. See Structural Drawings for additional criteria.

2.02 SPECIFICATIONS FOR POST TENSIONING STRANTS

- A. Strand diameter shall be 0.60 in.
- B. Strand area shall be 0.217 in.².
- C. Strand modulus of elasticity shall be 28,500,000 psi.
- D. Strand ultimate strength shall be 270,000 psi.

- E. Minimum guaranteed ultimate tensile strength shall be 58.59 kips.
- F. Temporary jacking force shall be 46.87 kips.
- G. Maximum design load shall be 35.15 kips.

2.03 GENERAL DESIGN

- A. The tank shall be constructed to the dimensions as indicated on the Contract Drawings and shall meet the design requirements for a post-tensioned concrete structure as recommended in ACI 318-11 and the Post-Tensioning concrete structure as recommended in ACI318-11 and the Post-Tensioning Institute design manual.
 - 1. Follow the modifications to ACI 318 as recommended by ACI 350 “Environmental Engineering Concrete Structures”.
- B. Design Method: Tank design shall be based on elastic analysis methods and shall take into account effects of all loads and prestressing forces during and after tensioning, and conditions of edge restraint at wall junctions with base slabs and top of slab if present. Consideration shall also be given to the effects of all loads and load combinations including stresses induced by temperature, moisture gradients, and seismic effects. Reinforced concrete shall meet the requirements set forth in Section 03300 Cast-In-Place Base of these Specifications and ACI 318, except as modified by ACI 350. The design must also meet the strength requirements of ACI 318 and 350. All applicable sections of the latest edition of ACI 318, including supplements and the precast and prestressed concrete chapters, shall be followed except when supplemented or modified by provisions of this specification and ACI 350.
 - 1. Design Loads: Loadings, including post-tensioning and or pre-stressing forces shall follow governing codes.
 - 2. Wall and Walkway Design:
 - a. All structures shall be constructed Type I cement with 25% class F fly ash substitution, with compression strength of 5,000 PSI at 28 days. The manufacturer shall submit daily compression break reports on the concrete.
 - b. All rebar shall be grade 60 ASTM A-615.
 - c. Precast concrete wall panels and walk ways shall be post-tensioned after erection with sheathed, grease encapsulated, 7 strand, 0.6 diameter cable. Anchor castings for unbonded tendons shall be totally encapsulated with a plastic coating to prevent corrosion.

- d. Precast concrete wall panels shall have a minimum thickness of 10 inches.
 - e. Precast concrete upper fixed beams shall be a minimum of 12 in. thick, except for the groove that fits over the wall.
 - f. All tanks shall be designed to be free standing and be able to withstand external soil pressures with an empty tank.
 - g. All internal walls shall be designed to have a full liquid level on either side, with the other side empty.
 - h. Tank designs that rely on bolted or welded connections from one wall panel to another will not be considered.
 - i. Design Method: Wall design shall be based on elastic analysis for stresses and deformations due to the loads outlined herein. Provide record calculations. Effects of shrinkage, temperature change, temperature gradient, and creep shall be taken into account. The designer shall consider all wall boundary conditions resulting from the construction joint details to be used at the top and bottom of the wall.
 - j. Tensioning Force: Tensioning steel shall be furnished to resist forces due to internal loads, after accounting for all stress losses.
 - k. Bearing Strips: Precast sections shall be set on Korolath bearing strips. A minimum of two bearing strips shall be provided for each stack. Bearing strips shall be multi-polymer plastic formulated for use by the construction industry as a bearing material.
 - l. Bearing Pads: Pads may be natural rubber, synthetic rubber, plastic, or neoprene, with hardness in the range of 40 to 50 durometers and the pad thickness shall be 1/2-inch minimum.
 - m. Watertightness: Where penetrations and joints are required, suitable methods and/or devices shall be employed to prevent leakage. Tanks shall be water tight.
 - n. Wall Thickness: The thickness of the concrete wall shall be such that membrane shell stresses are within the allowable stresses, but not less than 10-inches thick.
3. Floor Design:
- a. Reinforcing steel and cast-in-place concrete shall be as specified in Section 03300.

- b. Subgrade: Crushed stone to required depths necessary to support the live and dead loads of the proposed structure.
 - c. Watertightness: Where penetrations and joints are required, suitable methods and/or devices shall be employed to prevent leakage. Where the wall base shear is transferred into tension in the slab, additional post-tensioned and/or mild reinforcement steel shall be provided as required.
4. Post-Tensioning:
- a. Post-tensioned tank walls and floors shall be designed in accordance with ACI 318, and the Post-Tensioning Institute.
 - b. Post-tensioning shall be as follows:
 - 1) Horizontal wall tendons shall be either bonded multi-strand tendons or unbonded, encapsulated strands.
 - 2) Vertical wall tendons, floor tendons, and roof tendons (where applicable) shall be either bonded multi-strand tendons or unbonded, encapsulated strands.
 - 3) Tendon material and unbonded strand material shall be as manufactured by Lang Tendons, Inc., Dywigag-Systems International, USA or equal.
 - c. Strand shall be 270 ksi, 7-wire, stress relieved low relaxation strand conforming to ASTM-416-A, "Specifications for Uncoated Seven-Wire Stress-Relieved Low Relaxation Strand for Prestressed Concrete". Mill Test reports for each pack of strand shall be furnished to the Engineer upon request.
 - d. Corrosion Protection of bonded Tendons.
 - 1) Plastic ducts for tendons shall either be corrugated or smooth, 48 mil thickness. The horizontal ducts for a bonded system shall be made continuous in the vertical joint area between wall panels. Plastic ducts shall be chemically inert.
 - 2) Tendons are grouted in the ducts with Portland cement grout, in accordance with Chapter 18 of ACI 318.
 - e. Corrosion Protection of Unbonded Tendons.

- 1) Inert polymer polypropylene seamless sheath extruded directly on a grease encapsulated corrosion-inhibitor encased strand. The minimum thickness of the sheath shall be 30 mil.
- 2) Unbonded strands shall be in conformance with PTI “Specification for Unbonded Single Strand Tendons” for a corrosive environment.
- 3) Anchor castings for unbonded strand shall be totally encapsulated with plastic coating to prevent corrosion.

PART 3 CONSTRUCTION

3.01 SCOPE

- A. The purpose of this section is to modify requirements of placing, finishing, and curing concrete covered by the requirements of ACI 117, 301, 302, 304, 305, 306, 318, 347, 350 and 506 and to state additional requirements not included therein are specifically required for this post-tensioned tank construction.

3.02 CONCRETE

- A. Weather Limitations: Place in accordance with Section 03300 Cast-In-Place Base of these Specifications.
- B. Floor Slab:
 1. Joints shall be placed in accordance with Section 03300 Cast-In-Place Base.
 2. The floor shall be steel trowel finished.
- C. Precast Concrete Wall Panel:
 1. Concrete for each precast panel shall be placed in one continuous operation to prevent cold joints.
 2. Panel finish:
 - a. Smooth steel form finish on interior.
 - b. Steel trowel on finish exterior.
- D. Vertical Joints between Precast Panels:
 1. The 1-1/2” x 4” pocket between the vertical joints shall be filled with a rich cement grout to distribute the stress applied during post tensioning. In

addition a 3/8" x 3/4" bead of Sikaflex 1A shall be applied on each side of the wall joint.

3.03 FORMING

- A. Form work shall meet the requirements of ACI 347 and ACI 301.

3.04 NONPRESTRESSED STEEL REINFORCEMENT

- A. Steel Reinforcement shall be placed in conformance with ACI 301 and Section 03300 Cast-In-Place Base of these Specifications.
- B. The minimum cover over bar and welded wire fabric reinforcement shall be as specified in ACI 318 and 350.

3.05 POST-TENSIONING

A. Floor

- 1. If the floor is to be prestressed, place tendons orthogonally to ensure a biaxial state of compression in the floor slab. Mild reinforcement and post-tension tendons are to be tied snugly together, to protect against movement of reinforcement when concrete is placed. Tendon curvature must be smooth where curvature is necessary.
- 2. After the stressing of the tendons has been verified to be in accordance with ACI 318, all exposed ends of the tendons shall be protected from corrosion as specified in PTI. The recessed pockets required for the end anchorage system shall be filled with a non-shrink grout.

B. Walls

- 1. Threading the tendons through the wall panels shall begin after all panels are erected and plumbed.
- 2. Duct extensions shall be placed between the precast wall panels to make a continuous horizontal duct for grouted bonded systems.
- 3. Tendons shall be stressed as required by the design and in accordance with the referenced standards of ACI and PTI.
- 4. Grouting of bonded tendons shall be carried out as promptly as possible after tensioning. The total exposure time of the pre-stressing steel to other than a controlled environmental prior to grouting shall not exceed 30 days, or 14 days after tensioning unless special precautions, such as use of a vapor phase corrosion inhibitor, are taken to protect the prestressing steel. The methods or products used shall not jeopardize the effectiveness of the grout as a

corrosion inhibitor, nor the bond between the prestressed reinforcement and the grout. Vapor phase corrosion inhibitors shall be used in strict accordance with the manufacturer's recommendations. Additional restrictions may be appropriate for potential corrosive environments.

5. Grouting equipment shall be capable of grouting at a pressure of 200 psi. The tendon ducts must not be over pressurized during injection if blockage exists. Instead, the grout shall be washed out and the blockage removed.
6. All grout shall pass through a screen with 0.125-inch maximum clear openings prior to being introduced in the grout pump.
7. When quick setting occurs due to hot weather, the grout shall be cooled by acceptable methods such as cooling the mixing water to prevent blockages during pumping operations. When freezing weather conditions prevail during and following the placement of grout, adequate means shall be provided to protect the grout in the ducts from freezing until the grout attains a minimum strength of 800 psi.
8. After the grouting of the horizontal ducts is complete, the end anchorage recess pockets shall be cleaned, coated with a bonding agent and filled with a non-shrink grout.

3.06 TOLERANCES

A. Manufacturing tolerances listed below are modified from the PCI Manual for design MNL-121-77, and ACI 117-81.

1. Warpage – Maximum of one corner out of plane of the other three shall be 1/16 inch/ft. distance from the nearest adjacent corner.
2. Bowing or Camber – Concave or Convex – Any part of a flat surface shall not exceed (length of bow) 360 with maximum of 3/4 inch. Differential bowing or camber of adjacent panels shall not exceed 1/2 inch.
3. Thickness tolerance + 1/4 inch, thickness shall not be less than specified.
4. Length and width – per ACI 117-81 section 4.3.
5. Skew – measured by the difference in length of the two diagonals, +/- 1/8 inch per 6 ft of length with a maximum of +/- 3/8 inch.
6. Position tolerances – for cast-in-place items measured from datum line locations:

Weld plates	+/- 1 inch
Inserts	+/- 1/2 inch

Handling devices	+/- 3 inches
Reinforcing steel and welded wire fabric	+/- ¼ inch
Tendons	+/- 1/8 inch
Openings and blockouts	+/- ¼ inch
Haunches	+/- ¼ inch

B. Construction tolerances listed below are adopted from ACI 117-81 and ACI 301-89, for formed surfaces of cast-in-place concrete.

1. Variation from plumb:

¼ inch in any 10 ft. of length and max ¾ inch for entire length.

For exposed corners, control-joint grooves, or other conspicuous lines, the tolerance shall be ¼ inch in any 20 ft. of length and max. ½ inches for entire length.

2. Variation from level or from specified grade:

+/- ¼ inch in any 10 ft. of length, max.

+/- ¾ inch for entire length.

3. Variation of tank lines from established position in plan and related position of interior walls, columns, and partitions:

+/- ½ inch in any 20 ft. of length max.

+/- ¾ inch for entire length.

4. Position tolerances for cast-in-place items shall be the same as listed above for precast manufacturing.

5. Variation in thickness of slabs and walls and in the cross-sectional dimensions of columns and beams shall be +1/4 inch. Concrete thickness shall not be less than what is specified.

3.07 BEARING STRIPS

A. Bearing strips or shims shall be used to level the precast wall panels from the cast-in-place floor.

B. The bearing strips shall provide minimum resistance to movement of the wall during prestressing.

3.08 WELDING

A. Perform welding in compliance with AWS D 1.1, including qualification of welders.

B. Protect units from damage by field welding or cutting operations and provide non-combustible shield as required.

- C. Repair damaged metal surfaces by cleaning and applying a coat of liquid galvanizing repair compound to go galvanized surfaced and compatible primer to painted surfaces.

3.09 POWDER-ACTUATED FASTENERS

- A. Do not use powder-actuated fasteners (i.e. nail gun, etc.) for surface attachment of accessory items in precast, prestressed unit unless otherwise accepted by precast manufacturer and Engineer.

3.10 TEST FOR WATERTIGHTNESS:

- A. All concrete tanks designed to contain liquid shall be tested for water tightness as follows:
 - 1. After the concrete tanks have been constructed and properly cured, for a length of time to be determined by the Engineer, and prior to make any yard piping connections (piping external to tanks) and prior to any backfilling around the structures, the Contractor shall fill the tanks to the high water levels as indicated on the drawings with water.
 - 2. The water shall not be removed for a minimum of 48 hours unless otherwise instructed by the Engineer. The Engineer will check for evidence of leakage, and any areas which show evidence of leakage will be repaired at the direction of the Engineer.
 - 3. For the purposes of this specification, water tightness shall be defined as the absence of any damp or wet areas with discernible flow, and the loss of less than 0.05 percent of the water for each 24 hour period. If the water loss exceeds this amount, or if repairs are necessary because of damp or wet areas with discernible flow, the tank must be drained, the repairs made and the test repeated, at no additional cost to the Owner, until satisfactory completion of the test.
- B. All leakage tests and required repairs shall be included in the scope of work with no extra allowance for this work. Water required for the initial leakage test shall be provided by the owner.
- C. The method and materials for repairs shall be approved by the Engineer prior to the start of any repair work. All defective areas shall be cut or chipped and patched. Small leaks that are not due to defective concrete may be sealed with an approved coating.

END OF SECTION

SECTION 03501

LEAKAGE TESTS FOR CONCRETE STRUCTURES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. All fluid retaining concrete structures are required to be watertight and shall be tested by the Contractor and witnessed by the Engineer. Structures shall be tested with water as specified.
- B. All tests shall be conducted in a manner to minimize, as much as possible, any interference with the Contractor's work or progress.
- C. The Contractor shall notify the Engineer when the work is ready for testing, and tests shall be made as soon thereafter as possible. Personnel for reading meters, gauges, or other measuring devices and all other labor, equipment, air, water, and materials, including meters, gauges, fuel, bulkheads, and accessory equipment, shall be furnished by the Contractor.

1.02 REFERENCES

- A. AWWA Journal "A Summary Report on Concrete Water-Holding Structures," AWWA Committee on Concrete Holding Structures
- B. ACI Manual of "Environmental Engineering Practice Concrete Structures," ACI Committee 350 R-89, Part 4, Detroit, MI

1.03 QUALITY ASSURANCE

- A. Leakage tests of chambers and tanks shall be made before backfilling by filling the structure with water to the operating level, allowing a 24 hour presoak period, refilling if necessary to the operating level, and then observing the water surface level for the following 24 hours. Inspection for leakage will be made of the exterior surface of the structure, especially in the area around construction joints.
- B. Each section of water-holding structure which can be isolated in actual operation shall be isolated and tested for leakage.

1.04 ALLOWABLE LIMITS

- A. Leakage within the allowable limits will be accepted for structures from which there are no visible leaks and loss of water is less than 0.1% of the tank volume or the water surface water drops no more than 1/2 inch during the 24 hr test whichever is the most restrictive measurement method.
- B. If leakage exceeds the allowable limits, the structure shall be repaired by locating, removing and replacing the leaking portions of the structure, in accordance with the requirements of Section 03732 or by other means approved by the Engineer. Each structure shall be retested until leakage is within the specified limits.

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

3.01 WATER

- A. Water for filling of the structures will be supplied by the Contractor. The Contractor shall supply all hoses, pumps, labor, and other material to fill the structures. Water for subsequent fillings, if required, shall be at the expense of the Contractor.
- B. Water supply shall be obtained at the filling station located at 710 William Street, Dover, DE 19904. Water cannot be obtained through use of a fire hydrant. Connection to a fire hydrant is prohibited.

3.02 TEST RESULTS

- A. The test results shall be reported in writing to the Engineer on the same day that the tests are made.

3.03 ADDITIONAL TESTS

- A. Contractor shall perform additional tests, at no additional cost to the owner, as may be required to demonstrate concrete repairs are adequate and conform to the leakage criteria established herein.

END OF SECTION

SECTION 03732

CONCRETE REPAIR

PART 1 GENERAL

1.01 WORK INCLUDES

- A. Preparation of concrete and application of repair materials.
- B. Rehabilitation of concrete surfaces.

1.02 REFERENCES

- A. ANSI/ASTM C404 - Aggregates for Masonry Grouts.
- B. ANSI/ASTM C882 - Bond Strength of Epoxy-Resin Systems Used with Concrete.
- C. ASTM C33 - Concrete Aggregates.
- D. ASTM C150 - Portland Cement.

1.03 SUBMITTALS

- A. Submit narrative on repair methods and product data under provisions of Section 01340.
- B. Submit product data indicating product standards, physical and chemical characteristics, technical specifications, limitations, maintenance instructions, and general recommendations regarding each material.
- C. Submit manufacturer's installation instructions under provisions of Section 01340.
- D. Accurately record actual locations of structural reinforcement repairs and type of repair. Submit information under section 01700.

1.04 QUALITY ASSURANCE

- A. Materials Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience.
- B. Applicator: Company specializing in concrete repair approved by materials manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 01600.
- B. Store and protect products under provisions of Section 01600.
- C. Comply with instructions for storage, shelf life limitations, and handling.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

- A. Epoxy adhesive: Two-part epoxy adhesive meeting the following minimum characteristics:

<u>Characteristic</u>	<u>Test Method</u>	<u>Results*</u>
Bond Strength	ANSI/ASTM C882	1,900 psi
Tensile Strength	ASTM D638	4,800 psi
Flexural Strength	ASTM D790	7,400 psi
Compressive Strength	ASTM D695	9,500 psi

* 14 day Test Results

- B. Repair Mortar: A one component, ready to use with water, high strength polymer modified cementitious patching mortar for horizontal, vertical and overhead repair of concrete.
- C. Bonding Agent: Acrylic Bonding Agent.
- D. Portland Cement: ASTM C150, Type 1; gray.
- E. Sand: ASTM C33; uniformly graded, clean.
- F. Water: Clean and potable.
- G. Cleaning Agent: Commercial muriatic acid of 10 percent strength.

2.02 MIXING EPOXY ADHESIVE

- A. Mix in accordance with manufacturer's instructions for purpose intended.
- B. Mix components in clean equipment or containers. Conform to pot life and workability limits.

2.03 MIXING CEMENTITIOUS REPAIR MORTAR

- A. Mix mortar in accordance with manufacturer's instructions for purpose intended.
- B. Include bonding agent as additive to mix as recommended by manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Beginning of installation means installer accepts existing surfaces.

3.02 PREPARATION

- A. Clean concrete surfaces of dirt, laitance, corrosion, or other contamination by water blasting, sand blasting, acid washing as required by the manufacturers instructions. Rinse surface and allow to dry.
- B. Flush out cracks and voids with water to remove laitance and dirt.
- C. Provide temporary entry ports spaced to accomplish movement of fluids between ports, no deeper than the depth of the crack to be filled. Limit port size diameter to be no greater than the thickness of the crack. Provide temporary seal at concrete surface to prevent leakage of adhesive.
- D. For areas to be patched, remove broken and soft concrete 1/4 inch deep. Remove corrosion from steel. Clean surfaces mechanically; wash with acid and rinse with water.

3.03 REPAIR WORK

- A. Repair exposed structural, shrinkage, and settlement cracks of concrete by the epoxy injection method.
- B. Repair holes and cavities with Repair Mortar.

3.04 INJECTION - EPOXY RESIN ADHESIVE

- A. Inject adhesive into prepared ports under pressure using equipment appropriate

for particular application.

- B. Begin injection at lower entry port and continue until adhesive appears in adjacent entry port. Continue from port to port until entire crack is filled.
- C. Remove temporary seal and excessive adhesive.
- D. Clean surfaces adjacent to repair and blend finish.

3.05 APPLICATION - REPAIR MORTAR

- A. Trowel apply mortar mix as recommended by the manufacturer. Tamp into place filling voids at spalled areas.
- B. For patching honeycomb, trowel mortar onto surface, working into honeycomb to bring surface flush with surrounding area. Finish trowel surface to match surrounding area.
- C. Cover exposed steel reinforcement with epoxy mortar; feather edges to flush surface.

END OF SECTION

SECTION 04200

MASONRY

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Concrete unit masonry complete with reinforcement, anchorages and lintels.
- B. Mortar for masonry.
- C. Formed control joints.
- D. Installation of built-in items supplied by others.
- E. Cutting and fitting of masonry for other sections of work.
- F. Parging of masonry surfaces where indicated.
- G. Block insulation.

1.02 QUALITY ASSURANCE

- A. Perform masonry work in accordance with requirements of ANSI A41.1 unless indicated otherwise herein.
- B. Perform mortar work in accordance with requirements of ASTM C270 unless indicated otherwise herein.
- C. Provide evidence and test data confirming that products conform to standards stated herein.
- D. Single Source Responsibility for Masonry Units: Obtain mortar material of uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one manufacturer for each different product required for each continuous surface or visually related surfaces.
- E. Single Source Responsibility for Mortar Material: Obtain mortar material of uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source and producer for each aggregate.

1.03 TESTING

- A. Tests of mortar mixes will be performed to ensure conformance with requirements stated herein and to ensure mortar will not produce efflorescence.

- B. If mortar mixes do not conform to the requirements stated herein, re-establish and resubmit for further testing. Pay costs for required retesting.

1.04 REFERENCE STANDARDS

- A. Masonry work shall conform to applicable provisions of the following reference standards:

1. ASTM A82 - Cold-Drawn Steel Wire for Concrete Reinforcement.
2. ASTM A116 - Galvanized Coating for Concrete Reinforcement.
3. ASTM C150 - Portland Cement.
4. ASTM C216 - Facing Brick.
5. ASTM C62 - Building Brick.
6. ASTM C652 - Hollow Brick.
7. ASTM C5 - Quicklime for Structural Purposes.
8. ASTM C207 - Hydrated Lime for Masonry Purposes.
9. ASTM C144 - Aggregate for Masonry Mortar.
10. ASTM C90 - Hollow Load Bearing Concrete Masonry Units.
11. ASTM C145 - Solid Load Bearing Concrete Masonry Units.
12. ASTM C129 - Hollow Non-Load Bearing Concrete Masonry Units.
13. ASTM C55 - Concrete Building Brick.
14. ASTM C270 - Mortar and Grout for Unit Masonry.
15. ANSI A41.1 - Building Code Requirements for Masonry.

1.05 SUBMITTALS AND SAMPLE PANELS

- A. Submit samples and product data in accordance with Section 01340.
- B. Submit the following:
 1. Product data on masonry units, both brick and concrete block.
 2. Samples of units, anchors and reinforcement.

3. Product data on anchors and reinforcement.
4. Color charts for units submitted to owner.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Precautions against freezing: All masonry shall be protected against freezing for not less than forty-eight (48) hours after installation; and shall not be constructed below twenty-eight (28) degrees F on rising temperatures or below thirty-six (36) degrees F on falling temperatures without temporary heated enclosures or without heating materials or other precautions necessary to prevent freezing. Frozen materials shall not be used, nor shall frozen masonry be built upon.

1.07 PROTECTION

- A. Maintain protective boards at exposed external corners which may be damaged by construction activities. Provide such protection without damaging completed work.
- B. Keep expansion joint voids clear of mortar.
- C. Provide temporary bracing during masonry erection. Maintain in place until building structure provides permanent bracing.
- D. Cover top of incomplete masonry at end of work periods.
- E. Deliver masonry materials to project in undamaged condition.
- F. Store and handle masonry units to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion or other causes.
- G. Store cementitious materials off the ground, under cover and in a dry location.
- H. Store aggregates where grading and other required characteristics can be maintained.
- I. Store masonry accessories including metal items to prevent deterioration by corrosion and accumulation of dirt.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Substitutions: Items of same function and performance are acceptable in conformance with Section 01600.

2.02 MASONRY

- A. Concrete Blocks: ASTM C90 Hollow Core load bearing, CI45 Solid Code load bearing and CI29 Hollow Core Non-Load Bearing, Grade N, Type I, 8" x 16" face size and 12" x 16" face size, complete with corners, bases, bond beams, lintels and fillers to match and complement block units; standard weight. External corners bullnosed.
- B. Brick
 - 1. Face Brick: All face brick shall conform to ASTM C216, Type FBS, Grade SW.
 - a. Brick: Size, color and texture to be selected by Owner.
 - b. Provide special shapes as required to meet all field conditions. Match color and texture.

2.03 MORTAR MATERIALS

- A. Portland Cement: ASTM CI50 Type I.
- B. Aggregates: Standard masonry type, conforming to ASTM CI44 and free of frozen and foreign matter.
- C. Hydrated Lime: ASTM C207 Type S.
- D. Quicklime: Non-hydraulic Type ASTM C5.
- E. Premix Mortar: Commercially prepared type, ASTM C1142 mortar Type S.
- F. Water: Clean and free from injurious amounts of oil, alkali, organic matter or other deleterious materials. Potable.

2.04 REINFORCEMENT AND ANCHORAGES

- A. Reinforcing Steel for Bond Beams and Lintels: ASTM A615, Grade 60.
- B. Reinforcing Wire for Horizontal Reinforcing: ASTM A82 deformed steel with ASTM A116 Class 3 galvanized coating.
- C. Single Wythe Wall Horizontal Reinforcing: Truss type: galvanized steel construction; 3/16 inch side rods with 9 gauge cross ties. Dur-O-Wal or approved equal.
- D. Provide wall tie anchors. Wall ties shall be hot galvanized 7/8" wide x 7" long. 16 gauge.

2.05 CONCRETE

- A. Concrete for Bond Beams, Lintels and Filled Cores 4000 psi, as specified in Section 03300.

2.06 ACCESSORIES

- A. Control Joints: Preformed rubber, neoprene or polyvinylchloride of sizes and profiles as shown on the Contract Drawings. Rapid Control joint as manufactured by Dur-O-Wal Corporation or approved equal.
- B. Joint Filler: Closed cell polyvinylchloride, polyethylene or polyurethane, oversized 50% self expanding. The joint filler shall be compatible with the control joint material.

2.07 MORTAR MIX

- A. Provide minimum 1800 psi ASTM C270, Type S, mortar above finished floor. Provide minimum 2500 PSI ASTM C270, Type M, mortar below finished floor.
- B. Thoroughly mix mortar ingredients in quantities needed for immediate use.
- C. Do not use anti-freeze compounds or other additives, to lower the freezing point of mortar.
- D. Use mortar within two (2) hours of mixing at temperatures over 78 degrees F., and two and one half (2-1/2) hours at temperatures under 50 degrees F.
- E. If necessary, retemper mortar within two (2) hours of mixing to replace water lost by evaporation. Do not retemper mortar after two (2) hours of mixing.

2.08 CMU INSULATION

- A. See Section 07200 – Insulation.

PART 3 EXECUTION

3.01 PREPARATION

- A. Supply metal anchors for placement under other Sections. Provide sufficient quantity and direct their correct placement.
- B. Ensure items built-in by other trades for this work are properly located and sized.
- C. Establish lines, levels and coursing. Protect from disturbances.

3.02 WORKMANSHIP AND INSTALLATION

- A. Place masonry in accordance with lines and levels indicated on drawings.

- B. Fully bond external and internal corners and intersections.
- C. Isolate masonry partitions from vertical structural framing members with a control joint with mortar raked back 1/4 inch regardless of joint treatment.
- D. Buttering corners of joints, deep or excessive furrowing of mortar joint is not permitted.
- E. Do not shift or tap masonry after mortar has taken initial set. Where adjustment must be made, remove mortar and replace.
- F. Perform jobsite cutting of masonry with proper power tools to provide straight and true, unchipped edges.
- G. Where non-bearing masonry partitions extend to underside of floor, roof deck or structural system, stop masonry short 3/8 to 1/2 inch to allow for live load deflection. Fill gap with joint filler. Provide structural anchorage or retention in accordance with ANSI A41.1.
- H. Ensure masonry courses are of uniform height. Make vertical and horizontal joints equal and of uniform thickness. Lay in full bed or mortar, properly jointed with other work.
- I. Remove excess mortar and projections. Take care to prevent breaking masonry corners.
- J. Lay concrete block in running bond. Course 1 block unit and 1 mortar joint to equal 8 inches. Form concave mortar joints. Do not wet block when laying.
- K. Strike mortar joints of concrete block flush, where resilient floor base is scheduled.

3.03 TOLERANCES

- A. Maximum variation from masonry unit to adjacent masonry unit is 1/16 inch.
- B. Maximum variation from vertical and horizontal building lines is 1/4 inch in 10 feet.
- C. Maximum variation from cross sectional thickness of walls is plus or minus 1/4 inch.
- D. Maintain flush face on exposed masonry surfaces.

3.04 REINFORCEMENT AND ANCHORAGES

- A. Place masonry reinforcing and anchorages for concrete unit masonry as follows:

1. Provide walls with horizontal masonry reinforcing in every second CMU mortar joint above grade and at every course below grade.
2. Place horizontal masonry reinforcing in first and second joints above and below openings. Place continuous in first and second joint below top of walls.
3. Fully reinforce corners and intersections.
4. Lap masonry reinforcing splices minimum 6 inches.
5. Ensure that anchorages embedded in concrete or attached to structural steel members for concrete block are properly placed. Embed free end of anchorages in every second concrete block joint.

3.05 LINTELS

- A. Provide lintels as shown on drawings.

3.06 BOND BEAMS

- A. Reinforce as shown on the Contract Drawings.
- B. Place and consolidate concrete without disturbing reinforcing.

3.07 PIERS AND PILASTERS

- A. Place vertical reinforcing in piers and pilasters where shown. Grout in place with concrete.
- B. Use Pilaster style block units.

3.08 CONTROL JOINTS

- A. Install concrete joints where shown.
- B. Do not continue masonry reinforcing across control joints.

3.09 BUILT-IN WORK

- A. As work progresses, build-in hollow metal frames, window frames, steel angle lintels, nailing strips, anchor bolts, plates and other items supplied by other trades.
- B. Build-in items plumb and true.

- C. Bed anchors of hollow metal frames in mortar joints. Fill frame voids solid with mortar. Fill masonry cores with grout minimum 12 inches from framed openings.
- D. Do not build-in organic materials which will be subjected to rot or deterioration.

3.10 CUTTING AND FITTING

- A. Cut and fit masonry for chases, pipes, conduit, sleeves, grounds and other work. Cooperate fully with other sections of work to ensure correct size, shape and location.
- B. Obtain Engineer's review prior to cutting or fitting any area which is not indicated on drawings or which may impair appearance or strength of masonry work.
- C. Cut and rework existing masonry as shown for installation of new work. Tuck new work into existing.

3.11 PARGING

- A. Parge concrete block walls where shown in two uniform coats. Maintain total thickness shown.
- B. Dampen masonry walls prior to application.
- C. Scarify each coat to allow full bonding.
- D. Trowel finished surface smooth and flat with a maximum surface variation of 1:960.

3.12 WALL MOUNTED ACCESSORIES

- A. All accessories mounted on exterior walls shall have area between accessory and block filled with silicone suitable for outside use.

END OF SECTION

SECTION 05510

MISCELLANEOUS ALUMINUM FABRICATION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Custom fabricated aluminum items.

1.02 REFERENCE STANDARDS

- A. AA DAF-45 - Designation System for Aluminum Finishes
- B. AA SAA-46 - Standards for Anodized Architectural Aluminum
- C. ASTM B211 - Aluminum-Alloy Bars, Rods, Wire.
- D. ASTM B221 - Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubing.
- E. ASTM B241 - Aluminum-Alloy Seamless Pipe and Seamless Extruded Tubes.
- F. ASTM B429 - Aluminum-Alloy Extruded Structural Pipe and Tube.
- G. AWS D1.1 - Structural Welding Code, and the Aluminum Association Standards; latest addition.
- H. ASTM B209 – Aluminum and Aluminum Alloy Sheet and Plate.
- I. ASTM B210 – Aluminum and Aluminum Alloy Drawn Seamless Tubes.

1.03 SUBMITTALS

- A. Submit shop drawings of metal fabrications and product data on manufactured items in accordance with Section 01340.
- B. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners and accessories.
- C. Include erection drawings, elevations and details where applicable.
- D. Indicate welded connections using standard AWS welding symbols. Indicate net weld lengths.

1.04 QUALITY ASSURANCE

- A. Qualification of Installer: Use adequate numbers of skilled workman who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and methods needed for proper performance of the work of this section.
- B. Qualification of Manufacture: Products used in the work of this section shall be produced by manufacturers regularly engaged in the manufacture of similar items and with a history of successful production of these items.
- C. Requirements of Regulatory Agencies: All installations shall be in compliance with BOCA, Basic Building Code and Local Ordinances, and with the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Standards.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide and install items as indicated on the Drawings, complete in respect to function as intended.

2.02 MATERIALS

- A. Aluminum: Aluminum work shall be fabricated of plates and rolled or extruded shapes. All aluminum shall conform to the appropriate current ASTM Specifications and alloy listed in the following table:

<u>Application</u>	<u>ASTM Designator</u>	<u>ASTM Alloy</u>
Plate	B209	6061-T6
Nuts, 1/4" Tap and Under	B211	2024-T4
Nuts, 5/16" Tap and Over	B211	6061-T6
Rolled or Extruded Shapes	B308	6061-T6
Extruded Bar	B211	6061-T6
Drawn Tube	B210	6061-T6
Extruded Tube	B221	6061-T6
Pipe	B241	6061-T6
Shims	B209	1100-0

- B. Stainless Steel: Stainless steel work shall be fabricated of plates and rolled or cold drawn shapes. All stainless steel shall conform to the appropriate current ASTM Specifications and shall be Type 304L (extra low carbon).

2.03 FASTENERS & ANCHORAGE

- A. Anchorage shall be provided where necessary for fastening miscellaneous metal items securely in place. Anchorage not otherwise specified or indicated shall include slotted inserts made to engage with the anchors, expansion shields, and power-driven fasteners when approved for concrete; toggle bolts for masonry; machine and carriage bolts for aluminum.
- B. ASTM A193 GRB8 stainless steel bolts with (2) stainless steel plate washers and ASTM A194 GRF8 nuts.

2.04 FABRICATION

- A. Verify dimensions on-site prior to shop fabrication.
- B. Fabricate items with joints neatly fitted and properly secured.
- C. Fit and shop assemble in largest particle sections for delivery to site.
- D. Grind exposed welds smooth and flush with adjacent finished surfaces.
- E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts unobtrusively located consistent with design or structure, except where specifically noted otherwise.
- F. Make exposed joints flush butt type hair line joints where mechanically fastened.
- G. Supply components required for proper anchorage of metal fabrications. Fabricate anchorage and related components of same material and finish as metal fabrication, unless otherwise specified in schedule herein.

2.05 DISSIMILAR MATERIALS

- A. Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surfaces shall be protected with a coat of bituminous paint.

2.06 STOP GATES

- A. Stop gates shall be 1/4" thick 6061-T6 aluminum plate, reinforced as required to deflect no more than 1/30th of the span. Bottom edge shall be beveled for positive seating. Stop gate shall have 1/2" diameter bar handle.

- B. Stop gate frame shall be one piece 6061-T6 extruded aluminum frame mitered and welded continuously with one piece polymer guide. Frame shall be supplied with mounting flange to mount inside concrete channel.
- C. Stop gate and frame shall be Model 4001 by Washington Aluminum Company or approved equal.

2.07 STAIRS, HANDRAILS, AND GUARDRAILS

- A. All interior and exterior stairs, handrails, and guardrails shall be under the provisions of Section 05520.
- B. Provide stair layout in accordance with the Drawings.
- C. Provide detailed shop drawings for the design and layout of all connections and individual members.
- D. Provide aluminum handrails and guardrails in accordance with the 2012 IBC, per paragraph 2.02 Materials, and Section 05520, Handrails and Railings.

PART 3 EXECUTION

3.01 ERECTION

- A. Obtain Engineer's review prior to site cutting or making adjustments which are not part of scheduled work.
- B. Install items square and level, accurately fitted and free from distortion or defects.
- C. Make provision for erection stresses by temporary bracing. Keep work in alignment.
- D. Replace items damaged in course of installation.
- E. Perform field welding in accordance with AWS D1.1.
- F. After installation, touch-up field welds and scratched and damaged surfaces.
- G. Supply to appropriate sections, items requiring to be cast into concrete or embedded in masonry, complete with necessary setting templates.

END OF SECTION

SECTION 05520

HANDRAILS AND RAILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aluminum handrails, balusters, and fittings.

1.02 REFERENCE STANDARDS

- A. ASTM B211 - Aluminum-Alloy Bars, Rods and Wire.
- B. ASTM B221 - Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
- C. ASTM B214 - Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.
- D. ASTM A193B8 - Bolts for Attachment to Structural Steel.

1.03 DESIGN REQUIREMENTS

- A. All railings shall meet the OSHA requirements including but not limited to:
 - 1. Every open sided floor, or runway from which there is a drop of more than four feet shall be guarded by a rail or equivalent.
 - 2. Railing shall be provided with a toeboard wherever, beneath the open sides, a person can pass, there is moving machinery, or there is equipment with which falling material could create a hazard.
 - 3. Regardless of height, open sided floors, walkways, platforms or runways above dangerous equipment shall be guarded with standard railing and toeboards.
 - 4. A "Standard Railing" shall consist of a top rail, intermediate rail and posts and shall have a minimum vertical height of 42" nominal from the upper surface of top rail to floor. The top rail shall be smooth surfaced throughout its length. The intermediate rail shall be about halfway between the top rail and the floor. The ends of the rails shall not overhang the terminal posts to the extent of causing a projection hazard.
 - 5. Anchoring of posts and framing of members for railings of all types shall be of such construction that the completed structure shall be capable of withstanding a load of at least 200 pounds applied at any direction at any point on the top rail.

6. A "Standard Toeboard" shall be 4" nominal in vertical height from its top edge to the level of the floor. The toeboard shall be securely fastened in place with not more than 1/4" clearance above floor level. Where material is piled to such a height that a standard toeboard does not provide protection, paneling from floor to intermediate rail, or to top rail shall be provided.

B. Stainless steel chain shall meet OSHA requirements.

1.04 SUBMITTALS

A. Submit under provisions of Section 01340.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners and accessories.

1.05 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on Drawings and shop drawings.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Conforming to specifications but with experience in Handrail Systems for similar installations.

2.02 ALUMINUM RAILING SYSTEM

A. Rails: Welded railings 1.9 inch diameter, extruded tubing conforming to ASTM B241. Use 6063-T6 material.

B. Construction: Intersections of rails and posts shall be made by coping the pipe and continuously welding. Welds shall be ground smooth.

C. Mounting: Brackets and flanges mounted on concrete.

D. Exposed Fasteners: Flush countersunk screws or bolts; consistent with design of railing.

E. Finish: Mill finish.

2.03 STAINLESS STEEL CHAIN

A. 1/4" stainless steel straight link chain with safety snap hook, and 1/4" stainless steel eye bolts.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.
- B. Beginning of installation means erector accepts existing conditions.

3.02 PREPARATION

- A. Clean and strip items to bare metal where site welding is required.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install components plumb and level, accurately fitted, free from distortion or defects.
- C. Adjust railings prior to anchoring to ensure matching alignment at butting joints. Space posts not more than 6 feet on centers, unless otherwise shown.
- D. Railing shall be secured to supporting structures as follows:
 - 1. For removable handrail, post shall be secured by aluminum socket.
 - 2. For stationary handrail, mount with socket and expansion bolt system.
- E. Railing shall be shop fabricated. Field welds must meet factory requirements.

END OF SECTION

SECTION 05530

ALUMINUM GRATING AND FLOOR PLATES

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Metal gratings.
- B. Formed openings.

1.02 SUBMITTALS

- A. Submit Shop Drawings and Product Data under provisions of Section 01340.
- B. Provide details of grates, plates, supports, span and deflection table, openings, and perimeter construction details and tolerances.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Ohio Gratings, Inc., IKG Industries or equal.

2.02 MATERIALS

- A. Aluminum Plank Grating (6063-T6), heavy duty (plain sides), rectangular punch, upset pattern (WACO), 6" wide and plank lug anchoring device by Ohio Grating, IKG Industries or equal. Band grating around openings and edges. Thickness as stated on drawings.

2.03 PERFORMANCE

- A. A uniform load of 100 psf shall be assumed and deflection is not to exceed 0.25".

2.04 FASTENERS

- A. Fasteners: Stainless steel.

2.05 FINISHES

- A. Aluminum: Mill finish, slip resistant.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify that opening sizes and dimensional variations are acceptable to suit grating tolerances.
- B. Verify that supports and anchors are correctly positioned.
- C. Beginning of installation means acceptance of existing conditions.

3.02 INSTALLATION

- A. Install grates in accordance with manufacturer's instructions.
- B. Mechanically cut finished surfaces. Do not use flame cutting tools.

END OF SECTION

SECTION 06100

CARPENTRY

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Rough carpentry, finish carpentry and millwork.

1.02 QUALITY ASSURANCE

- A. Rough carpentry lumber: Visible grade stamp, of agency certified by National Forest Products Association (NFPA).
- B. When applicable, fabricate cabinetwork and site made finish carpentry items in accordance with recommendations of Quality Standards of Architectural Woodwork Institute (AWI).

1.03 REFERENCE STANDARDS

- A. MIL-L-1914-C Lumber and Plywood, Fire Retardant Treated
- B. PS 1 - Construction and Industrial Plywood
- C. PS 20 - American Softwood Lumber Standard
- D. PS 51 - Hardwood Decorative Plywood
- E. PS 58 - Basic Hardwood
- F. NFPA National Forest Products Association National Design Specification for Wood Construction.

1.04 SUBMITTALS

- A. Submit shop drawings in accordance with Section 01340.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Do not deliver shop fabricated carpentry items until site conditions are adequate to receive the work. Protect items from weather while in transit.
- B. Store indoors, in ventilated areas with a constant, minimum temperature of 60 degrees F., maximum relative humidity of 25 to 55 percent.

PART 2 MATERIALS

2.01 LUMBER, GENERAL

- A. Standard: For each use, comply with the "American Softwood Lumber Standard" PS 20 by the U.S. Dept. of Commerce. Nominal sizes are shown or specified; provide actual sizes complying with the minimum size requirements of PS 20 for the moisture content specified for each use.
1. Provide dressed lumber, *S7S*, unless otherwise shown or specified.
 2. Provide seasoned lumber with 19% maximum moisture content at time of dressing and complying with dry size requirements of PS 20, unless otherwise specified.

2.02 FRAMING LUMBER

- A. General: Where wood framing from 2" to 5" (but not including 5") in nominal thickness, and 2" or more in nominal width is shown on schedules; provide lumber complying with grading rules which conform to the requirements of the "National Grading Rule for Dimension Lumber" of the American Lumber Standards Committee established under PS 20.
- B. For light framing (2" to 4" thick and 2" to 4" wide), provide the following grade:
1. Standard grade.
- C. For structural framing (6" and wider and from 2" to 4" thick), provide the following:
1. No. 2 grade.
 2. Any species of the specified grade.

2.03 TRUSSES

- A. Truss length and pitch shall be as per plans and details on contract drawings and a total design load: LL = 30 psf, DL = 10 psf (top chord) and DL = 10 psf (bottom chord). Trusses shall be made of southern pine with #2 kd webbing, top and bottom chord and with 20 gauge hot dipped galvanized steel connector plates. Shop drawings shall be in accordance with the requirements of Section 01340 of the General Requirements and shall include layout, details, connections and design calculations and submitted for review prior to fabrication.

2.04 BOARDS

- A. General: Where lumber less than 2" in nominal thickness and 2" or more in nominal width is shown or specified, provide boards complying with dry size requirements of PS 20.

- B. Exposed boards: Where boards will be exposed in the finished work, provide the following:
 - 1. Moisture Content: 15% maximum, mark boards "MC-15".

 - 2. For paint and stain finish, where shown on schedule, provide the following:
 - a. No. 2 Boards, Southern Pine (SP1B).

- C. Concealed boards: Where boards will be concealed by other work, provide the following:
 - 1. Moisture Content: 15% maximum, mark boards "MC-15".

 - 2. Species and Grade: Provide one of the following:
 - a. Southern Pine (SPIB) No. 3 boards.
 - b. WCLB (any species) No. 3 boards.
 - c. WWPA (any species) "Construction" boards.

2.05 PLYWOOD

- A. Standard: For each use, comply with the requirements for "Softwood Plywood/Construction and Industrial" PS I by the U.S. Department of Commerce.

- B. Exposed Plywood: Where plywood will be exposed in the finished work, provide plywood as specified for the type of exposure and finish shown or scheduled, as follows:
 - 1. For textured or patterned surface, provide plywood of species, pattern and finish shown or scheduled, provide exterior type where exposed to exterior and interior type for other exposures.

- C. Concealed Plywood: Where plywood will be concealed by other work, provide interior type plywood C-D lugged grade, unless otherwise specified.

- D. For plywood sheathing, provide standard grade, with exterior glue.

2.06 ANCHORAGE AND FASTENING MATERIALS

- A. For each use, select proper type, size, material and finish complying with this specification and applicable Federal Specification.

2.07 TREATED WOOD

- A. Preservation Treatment: Where lumber or plywood is indicated as "treated", or is specified herein to be treated, comply with the applicable requirements of the American Wood Preservers Institute (AWPI).
 - I. Pressure-treat above-ground items with water-borne preservations complying with AWPI LP-2. After treatment, kiln-dry to a maximum moisture content of 15%. Treat indicated items and the following:
 - a. Wood cants, nailers, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers and waterproofing.
 - b. Wood sills, sleepers, blocking, furring, stripping and similar concealed members in contact with masonry or concrete.
 - c. Wood framing members less than 6" from ground.

PART 3 EXECUTION

3.01 EXECUTION

- A. Contractor shall use only sound, thoroughly seasoned materials of the longest practical lengths and sizes to minimize jointing. Use materials free from warp which cannot be easily corrected by anchoring and attachment. Sort out and discard warped material and material with other defects which would impair the quality of the work.
- B. Securely attach carpentry work to substrates by anchoring and fastening as shown and as required by recognized standards. Countersink nail heads on exposed carpentry work and fill holes. Set carpentry work accurate to required levels and lines, with members plumb and true and accurately cut and fitted.
- C. The Contractor shall use common wire nails, except as otherwise shown or specified. Use finishing nails for finish work. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting of wood; predrill as required.
- D. The Contractor shall use eight penny (2-1/2") hot dipped galvanized nails for roof sheathing. Ten penny (3") hot dipped galvanized common type nails shall be used for "toe nailing" and general framing.
- E. The Contractor shall fasten 2 x 3 furring to the concrete masonry units with 1/4" x 4", flat headed toggle bolts. A minimum of two bolts per furring section is required and

bolts will otherwise be placed on 8 foot centers. Also, the Contractor will supplement the toggle bolt with 1/4" x 1-3/4" heavy duty masonry nails placed 2 foot on center along the furring lumber.

- F. Contractor shall install furring plumb and level with closure strips at all edges and openings and shim with wood as required.
- G. Contractor shall provide furring of size and spacing shown, complete including all attachment devices.
- H. Plywood shall comply with recommendations of the American Plywood Association (APA) and shall be installed as recommended by the APA's "Guide to Plywood Sheathing for Floors, Walls, and Roofs" for the spacing of supports or types of substrates involved in the work. Provide plywood of thickness shown, or if not shown, provide as recommended by APA.
- I. Roof sheathing shall be nailed to rafters according to nailing schedule recommended for grade type and thickness by the American Plywood Association. Proceed with application only when sheathing is completely clean and dry.

END OF SECTION

SECTION 07200

INSULATION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Furnish insulation types specified herein.
- B. Insulation types included are:

Type 1 - Batt/blanket insulation with vapor barrier

Type 2 - Perimeter insulation - rigid

Type 3 - Block Insulation

Type 4 - Pipe Insulation

1.02 QUALITY ASSURANCE

- A. Thermal Resistivity: Where thermal resistivity properties of insulation materials and designed by R-values they represent the rate of heat flow through a homogenous material exactly 1" thick, measured by test method included in referenced material standard or otherwise indicated. They are expressed by the temperature difference in degrees F between the two exposed faces required to cause one BTU to flow through one square foot per hour at mean temperature indicated.
- B. Fire Performance Characteristics: Provide insulation materials which are identical to those whose fire performance characteristics, as listed for each material or assembly of which insulation is a part, have been determined by testing, per methods indicated below, by UL or other testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Surface Burning Characteristics: ASTM E84.
 - 2. Fire Resistance Ratings: ASTM E119.
 - 3. Combustion Characteristics: ASTM E136.
- C. Maximum Allowable Asbestos Content of Inorganic Insulations: Provide insulations composed of mineral fibers or mineral ores which contain less than 0.25% by weight of asbestos of any type or mixture of types occurring naturally as impurities as determined by polarized light microscopy test per Appendix A of 40 CFR 763.

1.03 DELIVERY OF MATERIALS

INSULATION

07200-1

- A. Furnish material in manufacturer's packaging, complete with installation instructions.

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01340:
 - 1. Samples of each type of insulation specified.
 - 2. Manufacturer's product data and installation recommendations.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Approved Manufacturers of Extruded Polystyrene Board Insulation:

Amoco Foam Products Company
Dow Chemical U.S.A.
Minnesota Diversified Products, Inc.
US Industries

- B. Approved Manufacturers of Glass Fiber Insulation:

Certainteed Corporation
Knauf Fiber Glass
Manville Corporation
Owens-Corning Fiberglass Corporation

- C. Approved Manufacturers of Concrete Block Insulation.

Concrete Block Insulating Systems, Inc., (Expanded Polystyrene)
Poly Master, Inc., (Polymaster R-501 Foamed in Place Insulation)

- D. Approved Manufacturers of Cellular Glass Pipe Insulation.

Pittsburgh Corning Corporation

2.02 MATERIALS

- A. Type 1 - BATT/BLANKET INSULATION WITH VAPOR BARRIER

- 1. Mineral Fiber Type: Glass or slag
- 2. Style: Batt or blanket as required by installation conditions.
- 3. Vapor Barrier: Foil - scrim - kraft laminated reflective membrane facing.

4. ASTM Compliance: ASTM C665 Type III Class A.
5. Surface Burning Characteristics: Max. flame spread - 25; maximum smoke developed - 50.
6. Thermal Resistivity (R-value): 3.14 per inch thickness, min.
7. Thicknesses: See drawings.

B. Type 2 - PERIMETER INSULATION - RIGID

1. Type: High density smooth finish extruded polystyrene board.
2. Edges: Square.
3. Size: 48" x 96" with longitudinal scores on 16" and 24" center.
4. Thickness: As shown on drawings.
5. Thermal Resistivity (R-value): 5.0 per inch thickness per ASTM C518.
6. Compressive Strength: 40 psi per ASTM D1621.
7. Water Absorption: 0.1% by volume maximum per ASTM C272.
8. Water Vapor Permeance: 1.0 perm max. per ASTM C96.
9. ASTM Compliances: ASTM C578 TType IV.
10. Density: 1.6 lbs. per cu. ft. per ASTM C578.

C. Type 3 – BLOCK INSULATION

1. Expanded Polystyrene
 - a. Type: Korfil Block Insulation; U-shape.
 - b. Size: To match design block on drawings.
 - c. ASTM Compliance: ASTM C578 Type 1.
 - d. Density – 0.90 to 1.14 lbs. per cu. ft. per ASTM C303 or D16.
 - e. Thermal Conductivity (K Factor): @ 25° F 0.23 BTU's per ASTM C177 or C518.

f. Thermal Resistance (R value): 4.35 @ 25° F per 1” thickness.

2. Foam in Place Insulation

a. Thermal Properties, per inch thickness: ASTM C177

- 1) .216 K value at 25 degrees F.
- 2) 4.63 R value at 25 degrees F./ 1” thickness
- 3) 8” block – R 11.5
- 4) 12” block – R 16.1

b. Flammability Classification: ASTM E84

- 1) Flame Spread: 5
- 2) Fuel Contribution: 0
- 3) Smoke Development: 10
- 4) Classification: Class 1

c. Sound Transmission Class: ASTM E413
STC44 for a 3-1/2 inch stud cavity wall

d. Maximum Shrinkage Allowable: 2% maximum

e. Wafer Vapor Transmission: ASTM E96
6.631 perms/inch

f. Water Vapor Absorption: ASTM 2482
10% by volume @24 hours/25 degrees F. @ 100% RH

g. Water Absorption (Surface Absorption): PM/MAT
<1.0% by volume @ 24 hours/25 degrees F. @ 100% RH

D. Type 4 – PIPE INSULATION

1. Insulation shall be provided for all buried pipe carrying liquids with less than three feet of cover, exposed piping carrying liquids and accessories between them.
2. Coordinate installation of insulation with electrical heat tracing of pipes.
3. Insulation shall be 1-1/2” cellular glass, ASTM C552-88, “K” value of 0.3 at 50° F, noncombustible. Insulation shall be FOAMGLAS as manufactured by Pittsburgh Corning Corporation or approved equal.
4. Jacketing

- a. Buried Piping – 125 mil thick, heat sealed high polymer asphaltic membrane with an integral gall scrim and 1 mil aluminum foil, with Mylar film surface.
- b. Exposed Piping – Aluminum, ASTM B209, 0.016 inch (0.51 mm) thick, smooth finish, type 3003. Pipe jacketing shall be Childers “Lock-on Jacketing” and fitting covers shall be “Ell-jacs and Tee-jacs” or approved equal.

2.03 AUXILIARY MATERIALS

- A. Polyethylene Vapor Retarder: 6-mil polyethylene film, with laboratory-tested vapor transmission rating of 0.2 perms, natural color.
- B. Adhesive for Bonding Insulation: Type recommended by insulation manufacturer, and complying with requirements for fire performance characteristics.
- C. Mechanical Anchors: Type and size indicated or, if not indicated, as recommended by insulation manufacturer for type of application and condition of substrate.
- D. Mastic Sealer: Type recommended by insulation manufacturer for bonding edge joints between units and filling voids in work.
- E. Crack Sealer for Board Insulation: Provide polymeric insulating foam in aerosol dispenser designed for filling voids in board insulation as recommended by manufacturer.

PART 3 EXECUTION

3.01 GENERAL

- A. Installation requirements apply both to insulation types which will be installed under this Section and to insulation types that will be furnished under this Section and installed under other Sections.

3.02 INSPECTION AND PREPARATION

- A. Installer shall examine substrates and conditions under which insulation work is to be performed. A satisfactory substrate is one that complies with requirements of the section in which substrate and related work is specified. Installer shall submit a written report listing conditions detrimental to performance of work in this section. Do not proceed with installation of insulation until unsatisfactory conditions have been corrected.
- B. Clean substrates of substances harmful to insulation or vapor retarders, including removal of projections which might puncture vapor retarders.

- C. Close off openings in cavities to receive poured-in-place insulation, sufficiently to prevent escape of insulation. Provide bronze or stainless steel screen (inside) where openings must be maintained for drainage or ventilation.

3.03 INSTALLATION, GENERAL

- A. Comply with manufacturer's instructions for particular conditions of installation in each case. If printed instructions are not available or do not apply to project conditions, consult manufacturer's technical representative for specific recommendations before proceeding with work.
- B. Extend insulation full thickness as shown over entire area to be insulated. Cut and fit tightly around obstructions, and fill voids with insulation. Remove projections which interfere with placement.
- C. Apply a single layer of insulation of required thickness, unless otherwise shown or required to make up total thickness.

3.04 INSTALLATION OF BATT/BLANKET INSULATION (TYPE 1)

- A. Apply insulation units to substrate by methods complying with manufacturer's recommendations. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- B. Seal joints between closed-cell (non-breathing) insulation units by applying mastic or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with mastic or sealant.
- C. Set vapor retarder faced units with vapor retarder to warm side of construction, except as otherwise indicated. Do not obstruct ventilation spaces, except for firestopping.
- D. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure air-tight installation.
- E. Set reflective foil-faced units accurately with air space in front of foil. Provide not less than 0.75" air space where possible.

3.05 INSTALLATION OF PERIMETER INSULATION (TYPE 2)

- A. On vertical surfaces, set units in adhesive applied in accordance with manufacturer's instructions. Use type of adhesive recommended by manufacturer of insulation.

3.06 INSTALLATION OF BLOCK INSULATION (TYPE 3)

- A. Inserts shall be installed in the cores of blocks at the Block Producer's Plant so that only blocks with inserts already installed are delivered to the job site. Inserts shall be

properly installed in accordance with manufacturer's specifications to allow blocks to be handled or saw cut without danger of insert dislodgment.

3.07 INSTALLATION OF FOAMED IN-PLACE INSULATION

- A. Fill cores using pressure fill or topfill method.
- B. Ensure cores or spaces are free of mortar or other restrictions to the free flow of foam.
- C. Verify that all work within the wall voids is complete prior to installation.
- D. Mortar and masonry must be relatively set prior to installation of insulation.
- E. For pressure fill installation, drill fill holes in masonry in accordance with Manufacturer's recommendations.
 - 1. Hole size: minimum 5/8 inch diameter, maximum 2 inch diameter.
- F. Foam insulation into CMU cores, in accordance with Manufacturer's instructions, to completely fill space and to flow into all crevices and voids.
 - 1. Install using pressure fill or top fill method to a uniform monolithic density without voids.
- G. Fill and point drill holes in masonry with mortar after installation, if pressure fill method is used.
- H. After setting remove any excess insulation outside of cavity and dispose of waste with other construction waste material.
- I. Allow 72 hours minimum after installation before painting of masonry walls.

3.08 INSTALLATION OF PIPE INSULATION (TYPE 4)

- A. Preparation
 - 1. Install materials after piping has been tested and approved.
- B. Installation
 - 1. Install materials in accordance with manufacturer's instructions.
 - 2. Continue insulation with vapor barrier through penetrations.
 - 3. In exposed piping, locate insulation and cover seams in least visible locations.

4. On exterior insulated piping, insulate all fittings, valves, unions, flanges, strainers, heat exchangers, filter bodies and pump heads.
5. On interior piping insulate all fittings and strainer, but insulation will not be required on valves, unions and flanges, but bevel and seal ends of insulation at such locations.
6. Provide an insert, not less than 6 inches long, of same thickness and contour as adjoining insulation, between support shield and piping, but under the finish jacket, on piping 2 inches diameter or larger, to prevent insulation from sagging at support points. Inserts shall be cork or other heavy density insulation material suitable for the planned temperature range. Factory fabricated inserts may be used.
7. Neatly finish insulation at supports, protrusions, and interruptions.
8. Exterior Applications: Cover pipe with aluminum jacket with seams located on bottom side of horizontal piping. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Aluminum jackets and fitting covers shall be used where possible, to cover the insulation.
9. Outside pipe bend insulation shall be accurately cut to fit the joints neatly. All ells, caps, tees, etc. shall be weatherproofed and finished with aluminum jacketing, as described above.
10. On the process lines insulation shall be stopped short of pipe flanges and beveled off to permit removal of flange bolts.
11. Outside piping shall be jacketed with smooth aluminum weatherproof jacketing, with moisture barrier. Jacketing shall be secured with metal bands as described in the foregoing paragraph.
12. Where sheet metal screws are used, sheet metal screws shall be #7 – ½”, Type A, binding head, furnished with neoprene washers attached, and shall be of 6061-T6 aluminum, or anodized 2024 aluminum.
13. Timing – Insulation shall preferably be done after hydrostatic or pneumatic testing. If insulation must begin prior to such testing, then all joints shall be left uncovered until the tests are completed.
14. Clean the pipe or equipment surface by brushing off all dirt and wiping clean of oil, water, and foreign matter before any insulation is installed.
15. Dry Insulation – All insulation shall be protected from moisture and weather before and during application. Insulation shall not be applied to surfaces which are damp or frosted. Weather vapor barrier finishes shall be applied to thoroughly dried insulation only.

16. Insulation Supports – Will be provided on horizontal lines at 10'-0" spacing. These pipes covering protection saddles are 12" long. For horizontal lines indoors and outdoors, cut away insulation so that pipe supports bear on the pipe.

3.09 INSTALLATION OF VAPOR RETARDERS

- A. General: Extend vapor retarder to extremities of area to be protected for vapor transmission. Secure in place with adhesives or other anchorage system as indicated. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those which have been stuffed with loose fiber-type insulation.
- B. Seal vertical joints in vapor retarders over framing by lapping not less than 2 wall studs. Fasten vapor retarders to framing at top, end and bottom edges, at perimeter of wall openings and at lap joints; space fasteners 16" o.c.
- C. Seal joints caused by pipes, conduits, electrical boxes and similar items penetrating vapor retarders with cloth or aluminized tape of type recommended by vapor retarder manufacturer to create an air-tight seal between penetrating objects and vapor retarder.
- D. Repair any tears or punctures in vapor retarders immediately before concealment by other work. Cover with tape or another layer of vapor retarder.

3.10 PROTECTION

- A. General: Protect installed insulation and vapor retarders from harmful weather exposures and from possible physical abuses, where possible by non-delayed installation of concealing work or, where that is not possible, be temporary covering or enclosure.

END OF SECTION

SECTION 07400

NONVENTILATED SOFFIT CEILING SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nonventilated vinyl soffits.
- B. Vinyl accessories and trim.

1.02 REFERENCES

- A. ASTM D 638 – Standard Test method for Tensile Properties of Plastics.
- B. ASTM D696 – Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between – 30 Degrees C and 30 Degrees C.
- C. ASTM D790 – Standard Test methods for Flexural properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- D. ASTM D1435 – Standard Test method for Outdoor Weathering of Plastics.
- E. ASTM D 1784 – Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- F. ASTM D1929 – Standard Test method for Ignition Properties of Plastics.
- G. ASTM D2843 – Standard Test method for Density of Smoke from the Burning or Decomposition of Plastics.
- H. ASTM D3679 – Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Siding.
- I. ASTM D4101 – Standard Specification for Propylene Plastic Injection and Extrusion Materials.
- J. ASTM D 4226 – Standard Test method for Impact Resistance of PVC Building Products.
- K. ASTM D 5206 – Standard Windload Resistance Test.
- L. ASTM E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
- M. ASTM E119 – Standard Test Methods for Fire Tests of Building Construction and Materials.

1.03 PERFORMANCE REQUIREMENTS

- A. PVC Fire Resistance: Provide vinyl siding products that meet or exceed the following ratings:
 - 1. Flame spread 20, fuel contribution 0, smoke density 360, per ASTM E 84.
 - 2. Minimum self-ignition temperature of 824 degrees F, per ASTM D 1929.
 - 3. Fire endurance classification of 1 hour, per ASTM E 119.

1.04 SUBMITTALS

- A. Make submittals under provisions of Section 01340.
- B. Product Data: Provide manufacturer's printed information and installation instructions on siding products and accessories.
- C. Samples: Provide 3 samples of siding products in colors specified, not less than 12 inches in length.

1.05 QUALITY ASSURANCE

- A. Installer: Provide installer with not less than three years of experience with products specified.

1.06 WARRANTY

- A. Provide manufacturer's standard lifetime limited warranty on siding products, transferable to new owners.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. CertainTeed Corporation, Vinyl Building Products Group, P. O. Box 860, Valley Forge, Pennsylvania 19482.
- B. Substitutions: Under provisions of Section 01600.

2.02 MATERIALS

- A. Polyvinyl Chloride: Provide siding materials made of PVC resin with cell classification of 13344-B, as defined by ASTM D 1784, meeting or exceeding the following properties:

1. Impact strength: 2.20 ft.-lbs. per inch at test temperature of 73 degrees F., and 1.30 ft.-lbs. per inch at test temperature of 32 degrees F, per ASTM D 4226.
 2. Tensile strength: 7,344 psi.
 3. Flexural modulus of elasticity in tension: 455,750 psi.
 4. Deflection temperature under load of 264 psi: 168 degrees F.
 5. Coefficient of expansion: .000034 in/in/degree F.
 6. Chemical resistance: Excellent.
- B. Vinyl Components: Provide products made of extruded polyvinyl chloride as specified in this section and manufactured to comply with requirements of ASTM D3679.
1. Provide elongated nailing slots on nailing flanges to allow for movement.
 2. Factory-notch ends of horizontal panels to form overlapping joints.
 3. Provide products that meet weathering requirements of ASTM D 1435.

2.03 NONVENTILATED VINYL SOFFIT PANELS

- A. Provide vinyl soffit panels designed to simulate finished wood.
- B. Style: IRONMAX, double 5-inch panels, .046 inches nominal thickness, smooth finish.
1. Provide non-vented soffit as shown on drawings.
 2. Color: White.

2.04 VINYL ACCESSORIES

- A. Provide coordinating vinyl accessories for complete and proper installation, whether or not specifically shown on the drawings.
- B. Color: Provide accessories in color matching adjacent soffit panels.
- C. Schedule of Accessories:
1. Starter strip: Vinyl.
 2. Soffit trim: F-channels.
 3. Butt End Joints: H channels.
 4. Soffit trim: Soffit cove molding.
 5. Miscellaneous channels and dividers to suit project conditions.

2.05 FASTENERS

- A. Provide galvanized or other corrosion-resistant nails as recommended by manufacturer of siding products.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Prior to commencing installation, verify governing dimensions of building and condition of substrate.

3.02 PREPARATION

- A. Examine, cleans, and repair as necessary any substrate conditions which would be detrimental to proper installation.
- B. Do not begin installation until unacceptable conditions have been corrected.

3.03 INSTALLATION

- A. General: Install products in accordance with the latest printed instructions of the manufacturer, with all components true and plumb.
- B. Nailing: Nail horizontal panels by placing nail in center of slot. Nail vertical panels by placing first nail at top of top slot and remaining nails in center of slots. Drive nails straight, leaving 1/16-inch space between nail head and flange of panel.
- C. Spacing: Allow space between both ends of siding panels and trim for thermal movement. Overlap horizontal panel ends one-half the width of factory pre-cut notches.
- D. Joints Horizontal Siding: Stagger lap joints in uniform pattern as successive courses of siding are installed.
- E. Fabrication of component profile on site is not permitted.
- F. Ensure site cuttings or burred edges do not remain on finished surfaces.
- G. Use concealed fasteners except where approved by Engineer.
- H. Place sealant or gaskets to arrest weather penetration. Maintain neat appearance.

3.04 CLEANING

- A. At completion of work, remove debris caused by soffit installation from project site.

END OF SECTION

SECTION 07460

FIBER CEMENT SIDING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fiber cement siding panels, fascia, moulding and accessories.

1.02 SUBMITTALS

- A. Submit under provisions of Section 01340.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Shop Drawings: Provide detailed drawings of atypical non-standard applications of cementitious siding materials which are outside the scope of the standard details and specifications provided by the manufacturer.
- D. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- E. Verification Samples: For each finish product specified, two samples, minimum size 4 by 6 inches (100 by 150 mm), representing actual product, color, and patterns.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: Minimum of 2 years experience with installation of similar products.
- B. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 - 1. Finish areas designated by Engineer.
 - 2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
 - 3. Refinish mock-up area as required to produce acceptable work.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store siding on edge or lay flat on a smooth level surface. Protect edges and corners from chipping. Store sheets under cover and keep dry prior to installing.
- C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.05 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.06 WARRANTY

- A. Product Warranty: Limited product warranty against manufacturing defects.
 - 1. Hardieplank lap and Hardipanel vertical siding for 50 years.
 - 2. Hardie Shingleside for 30 years.
 - 3. Hardie Trim for 10 years.
- B. Finish Warranty: Limited product warranty against manufacturing finish defects.
 - 1. When used for its intended purpose, properly installed and maintained according to Hardie's published installation instructions, James Hardie's ColorPlus finish with ColorPlus Technology, for a period of 15 years from the date of purchase: will not peel; will not crack; and will not chip.
- C. Workmanship Warranty: Application limited warranty for 2 years.

PRODUCT 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer: James Hardie Building Products, Inc. 26300 La Alameda, Suite 250, Mission Viejo, CA 92691. ASD.
- B. Requests for approval of equal substituions.

2.02 SIDING

- A. Code Compliance Requirement for Materials:
 - 1. US Department of Housing and Urban Development Materials Release 1263d.
 - 2. Non-asbestos fiber-cement siding where required to be non-combustible shall be tested in accordance with ASTM E136.
- B. Lap Siding: Hardieplank as manufactured by James Hardie Building Products, Inc.
 - 1. Type: Smooth 6-1/4 inches (159 mm) with 5 inches (127 mm) exposure.
- C. Vertical Siding: Hardiepanel as manufactured by James Hardie Building Products, Inc.
 - 1. Type: Stucco Vertical siding panel 4 feet by 8 feet (1219 mm by 2438 mm).
- D. Trim: Hardietrim Fascia and Moulding as manufactured by James Hardie Building Products, Inc.

2.03 FASTENERS

- A. Wood Framing Fasteners:
 - 1. Wood framing: 6d common corrosion resistant nails.

2.04 FINISHES

- A. Factory Finish: Refer to Exterior Finish Schedule.
 - 1. Product: ColorPlus by James Hardie. Provide standard colors for selection by Owner.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Nominal 2 inch by 4 inch (51 mm by 102 mm) wood framing selected for minimal shrinkage and complying with local building codes, including the use of water-resistive barriers or vapor barriers where required. Minimum 1-1/2 inches (38 mm) face and straight, true, of uniform dimensions and properly aligned.
 - 1. Install water-resistive barriers and claddings to dry surfaces.
 - 2. Repair any punctures or tears in the water-resistive barrier prior to the

installation of the siding.

3. Protect siding from other trades.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION – PLANK

- A. Install materials in strict accordance with manufacturer's installation instructions.
- B. Starting: Install a minimum ¼ inch (6mm) thick lath starter strip at the bottom course of the wall. Apply planks horizontally with minimum 1-1/4 inches (32 mm) wide laps at the top. The bottom edge of the first plank overlaps the starter strip.
- C. Allow minimum vertical clearance between the edge of siding and any other material in strict accordance with the manufacturer's installation instructions.
- D. Align vertical joints of the planks over framing members.
- E. Maintain clearance between siding and adjacent finished grade.
- F. Locate splices at least one stud cavity away from window and door openings.
- G. Use off-stud metal joiner in strict accordance with manufacturer's installation instructions.
- H. Wind Resistance: Where a specified level of wind resistance is required Harieplank lap siding is installed to framing members and secured with fasteners described in Table No. 2 in National Evaluation Service Report No. NER-405.
- I. Face nail to sheathing.
- J. Locate splices at least 12 inches (305 mm) away from window and door openings.
- K. Wind Resistance: Where a specified level of wind resistance is required Hardieplank lap siding is installed to framing members and secured with fasteners described in Table No. 2 in National Evaluation Service Report No. NER-405.

3.05 INSTALLATION – PANEL

- A. Install materials in strict accordance with manufacturer's installation instructions.
- B. Block framing between studs where Hardiepanel siding horizontal joints occur.

- C. Place fasteners no closer than 3/8 inch (9.5 mm) from panel edges and 2 inches (51 mm) from panel corners.
- D. Allow minimum vertical clearance between the edge of siding and any other material in strict accordance with the manufacturer's installation instructions.
- E. Maintain clearance between siding and adjacent finished grade.
- F. Specific framing and fastener requirements refer to Tables 2 and 3 in National Evaluation Service Report No. NER-405.
- G. Overlapping the starter strip.
- H. Apply subsequent courses horizontally with a minimum 10 inch overlap at the top and a minimum 2 inch (51 mm) side lap. The bottom edge of the first two courses overlaps the starter strip.
- I. Fasten between 1/2 inch (13 mm) and 1 inch (25 mm) in from the side edge and between 8-1/2 inches (216 mm) and 9 inches (229 mm) up from the shingle bottom edge.
- J. Allow minimum vertical clearance between the edge of siding and any other material in strict accordance with the manufacturer's installation instructions.
- K. Ensure vertical joints of overlapping shingle course do not align.
- L. Wind Resistance: Where a specified level of wind resistance is required Hardie Shingleside cladding is installed to substrate and secured with a minimum two fasteners described in Table No. 6, 7 and 8 in National Evaluation Service Report No. NER-405.

3.06 INSTALLATION – TRIM FASCIA AND MOULDING

- A. Install materials in strict accordance with manufacturer's installation instructions. Install flashing around all wall openings.
- B. Fasten through trim into structural framing or code complying sheathing. Fasteners must penetrate minimum 3/4 inch (19 mm) or full thickness of sheathing. Additional fasteners may be required to ensure adequate security.
- C. Place fasteners no closer than 3/4 inch (19 mm) and no further than 2 inches (51 mm) from side edge of trim board and no closer than 1 inch (25 mm) from end. Fasten maximum 16 inches (406 mm) on center.
- D. Maintain clearance between trim and adjacent finished grade.

- E. Trim inside corner with single board.
- F. Outside Corner Board: For ¾ inch (19 mm) trim only. Install single board of outside corner board then align second corner board to outside edge of first corner board. Do not fasten Hardietrim board to Hardietrim board.
- G. Outside Corner Board: For 1 inch (25 mm) and 1-1/2 inches (38 mm) trim only. Pre Build corners by fastening trim together with 16 ga. Corrosion resistant finish nail ½ inch (13 mm) from edge spaced 16 inches (406 mm) apart, weather cut each end spaced minimum 12 inches (305 mm) apart.
- H. Allow 1/8 inch gap between trim and siding.
- I. Seal gap with high quality, paint-able caulk.
- J. Shim frieze board as required to align with corner trim.
- K. Install Hardietrim fascia over structural subfascia.
- L. Overlay siding with Hardietrim moulding at windows, doors and inside corners.
- M. Fasten through overlapping boards. Do not nail between lap joints.
- N. Overlay siding with single board of outside corner board then align second corner board to outside edge of first corner board. Do not fasten Hardietrim boards to Hardietrim boards.
- O. Shim frieze board as required to align with corner trim.
- P. Install Hardietrim fascia over structural subfascia.

3.07 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 07610

METAL ROOFING

PART 1 GENERAL

1.01 SUMMARY

- A. Scope of Work: Furnish and install a pre-formed, tension leveled, metal panel system with continuous interlocking panel connections. Provide all necessary accessories, ridges, hips, valleys, eaves, rakes, corners, miscellaneous flashings, attachment clips and closure members to ensure a weathertight installation.

1.02 REFERENCES

- A. AA DAF-45 – Designation System for Aluminum Finishes; The Aluminum Association, Inc.
- B. AAMA 607.1 – Voluntary Guide Specification and Inspection Method for Clear Anodic Finishes for Architectural Aluminum; American Architectural Manufacturers Association.
- C. AAMA 608.1 – Voluntary Guide Specification and Inspection Methods for Electrolytically Deposited Color Anodic Finishes for Architectural Aluminum; American Architectural Manufacturers Association.
- D. ASTM A 653/A 653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- E. ASTM A 755/A 755M – Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil Coating Process for Exterior Exposed Building Products.
- F. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- G. ASTM B 370 – Standard Specification for Copper Sheet and Strip for Building Construction.
- H. ASTM E 1592 – Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.

- I. ASTM E 283 – Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- J. ASTM E 331 – Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
- K. Coating Performance Reference Standards. (Refer to section 2.2).
- L. ASCE 7-10 – Minimum Design Loads for building and Other Structures, American Society of Civil Engineers.
- M. BOCA National Building Code (BOCA); Building Officials and Code Administrators International, Inc. (BOCA).
- N. U.S. Army Corps of Engineers’ Specifications CEGS07416: Air Pressure Test in Accordance with Guide Specifications for Military Construction.
- O. UL 580 – Standard for Tests for Uplift Resistance of Roof Assemblies.

1.04 PERFORMANCE REQUIREMENTS

- A. Panel system shall be designed to safely resist snow load of 40 psf and wind up to 105 mph.
- B. Structural uniform uplift load capacity of the panel system shall be determined in accordance with ASTM E-1592: Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference as follows:
 - 1. The factor of safety on the test results shall be 1.65 for the panel and clip, ultimate loads with no increase for wind.
 - 2. The factor of safety shall be 2.5 in metal, 3.0 in wood, and 4.0 in masonry.
 - 3. Design uplift capacity for conditions of gauge span or loading other than those tested may be determined by interpolation of test results, structural load calculations, clip strength capacity and fastener values.
 - 4. Maximum deflection under design loads: 1/240 of span.
- C. Design and size components to withstand load caused by wind pressures as specified in ASCE 7-10.

- D. Water Penetration of the Panel System – Panel system shall provide no uncontrolled leakage at 12.00 PSF pressure when tested by an independent testing laboratory in accordance with ASTM test procedure E331.
- E. Air Infiltration – Panel system shall allow no more than .08 cfm/sq. ft. of air infiltration when tested by an independent testing laboratory in accordance with ASTM test procedure E283.
- F. Provide Class 90 rated panel system tested in accordance with UL580 Test for Uplift of Roof Assemblies.
- G. System movement – Accommodate movements due to thermal expansion and contraction, dynamic loading and deflection of structural support system without damage to panel system or loss of weatherproofing capability. Clip design for panel attachment shall accommodate an unlimited allowance for expansion and contraction in the longitudinal direction of the panel system.
- H. Fabricate panels in full length with no end laps when panel lengths are 70'-0". Manufacturers' details for end lap conditions shall be strictly adhered to.
- I. All panels shall be fastened to the framing members or underlayment with concealed anchor clips designed to allow for thermal movement of the panels except where specific fixed points are required.
- J. Clip fastened panels should not have exposed fasteners except to fasten flashings or as indicated on the drawings.
- K. Provide fastener pull-out test report and calculations.
- L. Roof panels, anchor clips, closures, flashings and accessories shall be the product of a single manufacturer.
- M. All trim and flashing components shall be fabricated in lengths of 12'-0" to minimize joint details. Allowance for thermal expansion and contraction of trim and flashing components shall be incorporated in their design.
- N. Drainage – Provide positive drainage to exterior to prevent moisture from entering building enclosure or condensation occurring within exterior building envelope.

1.05 SUBMITTALS

- A. Submit under provisions of Section 01340.
- B. Manufacturer's Certifications:
 - 1. Certified statement from the panel manufacturer that the manufacturer has a minimum of ten (10) years experience in the roll forming process of metal panel systems.
 - 2. Certified statement from the panel manufacturer that panels are tension-leveled during the roll-forming process.
- C. Product Data: Manufacturer's current product specifications and installation instructions.
- D. Test Reports: Submit the following test reports, certified by an independent testing laboratory or independent professional engineer, to verify that the proposed materials will meet the performance criteria of the specification.
 - 1. Wind load performance of panels and anchors.
 - a. ASTM E-1592
 - b. Fastener pull out test and calculations.
 - x. UL580 Class 90 test data.
 - 2. Air infiltration performance. (ASTM E-283).
 - 3. Water penetration performance. (ASTM E-331).
 - 4. Coating quality.
- E. Shop Drawings: Prior to fabrication, Contractor shall submit drawings showing a small scale roof plan and/or elevations, as required. Show details of trim and flashing conditions, fastening and anchoring methods, weatherproofing techniques, terminations, and penetrations of metal roofing at work. Panel installation shall not start until drawing approval by architects.
- F. Selection Samples: Submit samples of the following: metal panel, anchor clips, fasteners, closures, sealant and actual metal chips with full range of colors (minimum of twenty) available for selection.

- G. Verification Samples: Submit two samples of each type of metal panel required, not less than 12 inches (305 mm), and illustrating finished panel profile, color, sheen, and texture.
- H. Upon bid proposal contractor is to provide qualifications and/or exceptions to the drawings and specifications.
- I. Contract Close-out Submittal: Coordinate with Section 01700. Submit specified warranties, maintenance instructions and other closet submittals pertaining to this section.

1.06 QUALITY ASSURANCE

- A. All panels are to be factory formed and packaged as per job requirements.
- B. Manufacturer Qualifications: Minimum of 10 years of experience in factory-fabrication and roll-forming of metal panels.
- C. Installer Qualifications: Company specializing in the type of work required for this project, with not less than 2 years of documented experience applying this type of panel system with successful completion of project of similar scope.
- D. Pre-Installation Meeting: Convene meeting between panel installer, general contractor, and Engineer not less than one week prior to beginning installation to review the following: acceptable substrates, materials, colors, gauges, changes in scope of work, etc.
- E. Regulatory Requirement: All local building code requirements are to be followed for both design and installation of metal panel system.
- F. Field Measurements: Field measurements should be taken by the installer for verification of dimensional correctness in relationship to original plans, prior to providing manufacturer with a bill of material.
- G. Source Quality Control: Provide actual test criteria and/or calculations where applicable pertinent to design criteria within project specifications.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Comply with provisions of Section 01600.
- B. Order materials based on field measurements, not on construction drawings.
- C. Package panels at factory.

- D. Installer shall coordinate with general contractor as to scheduled delivery time after receipt of field verified bill of material by manufacturer as it related to actual project scheduling.
- E. Delivery of materials shall be made only when suitable facilities for storage and protection are made available.
- F. Upon receipts of delivery of metal panel system and prior to signing the delivery ticket, the installer is to examine each shipment for damage and for completion of the consignment.
- G. Protect materials from damage during transit and at storage facility or project site.
- H. Store in a dry environment to prevent water damage from the elements and condensation. Store panels to allow for positive drainage in the event that materials are exposed to moisture.
- I. Do not expose panels and/or flashing with strippable protective film to direct sunlight or extreme heat.
- J. Do not allow storage of other trade materials or staging of other work on finished product.

1.08 WARRANTY

- A. The manufacturer shall warrant the Products to be free from defects in materials and workmanship for a period of 20 years from the date of Substantial Completion. A written manufacturer's warranty shall be provided.

PART 2 PRODUCTS

2.01 ROOFING PANELS

- A. Provide panels of continuous lengths from ridge to eaves or from top to eaves on shed roof designs. Panels shall be 12 inches wide with a minimum 1.75" inch high vertical legs and two 0.37 inch stiffening ribs at 4 inches on center between the legs to minimize oil-canning and telegraphing of structural members. Leading vertical leg shall have a continuous groove in the rib top for anti-siphon protection when hook-rib top of next panel is locked over leading vertical leg to form the standing seam. Panels from coil stock shall be formed without warping, waviness or ripples not a part of the panel profile, and shall be free of damage to the finish coating system.

2.02 MATERIALS

- A. Aluminum Sheet: ASTM B 209, minimum yield strength 17,000 psi.
- B. Thickness: 0.40"
- C. Finish: Alclad fluorocarbon baked enamel exterior and neutral washcoat interior.
- D. Color: Selected by owner.
- E. Coating: Provide factory applied, thermally cured coating to exterior and interior of metal roof and wall panels and metal accessories. Provide exterior finish top coat of 70 percent resin polyvinylidene fluoride with not less than 0.8 mil dry film thickness. Provide exterior primer with not less than 0.8 mil dry film thickness. Interior finish shall consist of the same coating and dry film thickness as the exterior coating 0.5 mil. Provide exterior and interior coating meeting test requirements specified below. Tests shall have been performed on the same factory finish and thickness provided. Provide clear factory edge coating on all factory cut.
 - a. Gloss: ASTM D-523-89 at 60°- Standard shall have a gloss of 30 \pm .
 - b. Pencil Hardness: ASTM D-3363-92a Eagle Turquoise Drafting Lead: HB-H.
 - c. Flexibility T-Bend: ASTM D-4145-83 No cracking or tape removal of film at 1-T bend (aluminum); 2-T bend (coated steel).
 - d. Flexibility Mandel: ASTM D-522-93a 180 Bend around 1/8" mandrel – No cracking.
 - e. Adhesion: ASTM D-3359-95a Rev. impacted 1/16" crosshatch – No adhesion loss.
 - f. Reverse Impact: ASTM D-2794-93 Impact in in./lb. = 1,500 x metal thickness in inches (aluminum) or 3,000 x metal thickness in inches (coated steel). No cracking or adhesion loss.
 - g. Abrasion Resistance, Falling Sand Test: ASTM D-968-93 Liters to expose 5/32" of substrate – 50 to 80 liters.
 - h. Abrasion Resistance, Transit: Proprietary Procedure, panels tested face-to-back – No disfigurement.

- i. Mortar Resistance: AAMA 2605, Test #7.7.2 24 hr. Pat Test – No effect.
- j. Detergent Resistance: ASTM D-2248-93, 3% DET., 100° F, 72 hrs. immersion – No effect.
- k. Graffiti Resistance: Cleanability of Deface Panels, spray paint, various marking pens – No disfigurement after cleaning.
- l. Acid Pollutants Resistance Test: ASTM D-1308-87 10% muriatic acid, 15 min. – No effect; 20% sulfuric acid, 18 hrs. – No effect; 20% sulfuric acid, 18 hrs. – No effect; AAMA 2605, Test #7.7.3.1 70% nitric acid vapors, 30 mins. - <5 units color change.
- m. Acid Rain Resistance Test: KESTERNICH Sulfur dioxide cyclic test – 10 cycles aluminum – No objectionable color change.
- n. Alkali Resistance: ASTM D-1308-87 10%, 25% sodium hydroxide, 1 hr. – No effect.
- o. Salt Fog: ASTM B-117-95 5% Salt Fog at 95° F – Passes 3,000 hours (aluminum) with less than 1/16” maximum average creepage from scribe; passes 1,000 hours (coated steel) with less than 1/8”.
- p. Humidity Test: ASTM D-2247-94, D-714-87 100% Relative Humidity at 95° F – Passes 3,000 hours (aluminum) with no blisters; passes 1,500 hours (coated steel) with no blisters.
- q. Color Retention, Weatherometer Test: ASTM D-822-96, G23-93, G26-90, G53-953 – Passes 5,000 Hours. No objectionable chalking, color change or adhesion loss.
- r. Color Retention, Florida Exposure: ASTM D-2244-93 Florida exposure: 10 years at 45° S. – Maximum 5 units change.
- s. Chalking Resistance: ASTM D-4214-89, Test Method D659 Florida exposure: 10 years at 45° S. – Maximum rating of 8.
- t. Film Erosion Rate: Average mil eroded/year, Florida exposure: 10 years at 45° S – 0.01 mils/year.

2.03 ACCESSORIES

- A. Provide formed accessories of same gage and finish as the primary panel system, unless otherwise indicated on the drawings, compliant with specified requirements.

- B. All flashing components shall be fabricated in a minimum of 12'-0" lengths.
- C. Anchor Clips: Required based upon panel type. Clips are to be a concealed type; designed to allow for thermal movement of panels. Clips are to be a minimum of 22 GA stainless steel.
- D. Sealants:
 - 1. As specified in Section 07920.
 - 2. Apply sealant where necessary to complete a weathertight roof system.
 - 3. Consult manufacturer for sealant recommendations.
- E. Fasteners: As recommended by manufacturer for project conditions and panel type.
- F. Ridge Vent: Manufacturer's standard for specified roof panels.

2.05 FABRICATION

- A. Panel shall be factory fabricated with integral lock and seam design.
- B. Materials are to be tension leveled during the roll forming process.
- C. Fabricate panels up to 70 feet (21 m) long in one piece without transverse seams. Panels over 70 feet (21 m) long may be fabricated with seams; use manufacturer's standard end lap details.
- D. Factory-fabricate trim and flashing components in minimum 12 foot (3.65 mm) lengths, with allowance for thermal movement in joint design; unless project site conditions prohibit such.
- E. Clips and related accessory items to be supplied by panel manufacturer as a single source responsibility.
- F. Form all components true to shape, accurate in size, square and free from distortion or defects. Cut panels to precise lengths indicated on approved shop drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Inspect substrates to verify that they are in proper condition, spaced correctly, plumb, and are ready to receive panels and accessories.
 - 1. Notify the architect in writing if substrates are not suitable for application of panel system.
 - 2. Verify actual dimensions in field prior to order materials.

3.02 INSTALLATION

- A. Install metal panels and accessories in strict accordance with manufacturer's instructions, shop drawings, and applicable codes.
- B. Protect surfaces from coming in contact with cementitious materials and dissimilar metals with a neutral coating such as bituminous paint.
- C. Fasten panels to structural supports with concealed anchor clips, except where fixed attachment points are indicated.
- D. Entire system shall be installed plumb, level, and true to line.

Fully interlock panels with adjacent panels; apply sealants as recommended by panel manufacturer to achieve weathertight installation.

- E. Roll-formed panels designed for eave to ridge installation should be installed with no transverse seams.
- F. Workmanship complies with standards established by the Architectural Sheet Metal community.
- G. Care should be taken during handling of panels to prevent bending, twisting, abrasion, scratching, denting, etc.
- H. Do not allow shavings, metal dust, or chips to fall on panels.

3.03 ADJUSTING AND CLEANING

- A. Remove all protective masking from material immediately after installation.
- B. Touch up only minor abrasions with matching pain provided by panel manufacturer. Remove and replace panels that cannot be satisfactorily touched up.

- C. Sweep and remove chips, shavings, and dust from roof on a daily basis during installation period. Leave installed work clean, free from grease, finger marks and stains.
- D. Upon completion of installation, remove scraps and debris from project site.

3.04 PROTECTION

- A. Provide protection as required to assure that completed work of this section will be without damage or deterioration at date of substantial completion.
- B. Protect work area as required to protect from damage by other trades.
- C. Safety clothing, equipment and precaution must be utilized according to safety standards.

END OF SECTION

SECTION 07631

GUTTERS AND DOWNSPOUTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Precoated Aluminum gutters and downspouts for all roof edges of Building as indicated on Drawings.
- B. Precast concrete splash pads.

1.02 REFERENCES

- A. ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate.
- B. SMACNA - Architectural Sheet Metal Manual.

1.03 SUBMITTALS

- A. Submit under provisions of Section 01340.
- B. Shop Drawings: Indicate locations, configurations, jointing methods, fastening methods, locations, and installation details.
- C. Product Data: Provide data on prefabricated components.
- D. Samples: Submit two samples, 12 inch long illustrating component design, finish, color, and configuration.

1.04 QUALITY ASSURANCE

- A. Conform to SMACNA Manual for sizing components for rainfall intensity determined by a storm occurrence of 1 in 10 years.

1.05 REGULATORY REQUIREMENTS

- A. Conform to applicable code for size and method of rain water discharge.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 01600.
- B. Stack preformed and prefinished material to prevent twisting, bending, or abrasion, and to provide ventilation. Slope to drain.

- C. Prevent contact with materials during storage which may cause discoloration, staining, or damage.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Aluminum Sheet: ASTM B209, alloy, temper; .032 inch thick; plain finish, shop pre-coated with primer and two coats of exterior enamel paint; color as selected by Owner.

2.02 COMPONENTS

- A. Gutters: SMACNA Rectangular style profile.
- B. Downspouts: SMACNA Rectangular profile.
- C. Accessories: Profiled to suit gutters and downspouts.
- D. Splash Pads or Blocks: Precast concrete type, standard profiles; minimum 3000 psi (21 Mpa) at 28 days, with minimum 5 percent air entrainment.

2.03 ACCESSORIES

- A. Anchorage Devices: SMACNA requirements. Type recommended by fabricator.
- B. Gutter Supports: Concealed Brackets.
- C. Downspout Supports: Brackets.
- D. Fasteners: Aluminum finish exposed fasteners same as flashing metal.

2.04 FABRICATION

- A. Form gutters and downspouts of profiles and sizes to SMACNA requirements.
- B. Fabricate with required connection pieces.
- C. Form sections square, true, and accurate in size, in maximum possible lengths, free of distortion or defects detrimental to appearance or performance. Allow for expansion at joints.
- D. Hem exposed edges of metal.
- E. Fabricate gutter and downspout accessories; seal watertight.

2.05 FINISHES

- A. Shop paint to as approved by the Owner.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work.

3.02 INSTALLATION

- A. Install gutters, downspouts, and accessories in accordance with manufacturer's instructions.
- B. Join lengths with seams sealed watertight. Flash and seal gutters to downspouts and accessories.
- C. Slope gutters 1/16 inch per foot minimum.
- D. Seal metal joints watertight.
- E. Install splash block at each downspout location.

END OF SECTION

SECTION 07710

PREFABRICATED ROOF SPECIALTIES

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Soffit vents.
- B. Roof ridge vents.
- C. Pipe seals.

1.02 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 01340.
- B. Indicate on shop drawings, configuration and dimension of components, adjacent construction, required clearances and tolerances, and other affected work.
- C. Provide product data on shape of components, materials and finishes, anchor types and locations.
- D. Submit samples under provisions of Section 01340.
- E. Submit two samples 12 inches long illustrating component shape, finish, and color.
- F. Submit manufacturer's installation instructions under provisions of Section 01340.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Ridge vents: Mid-America Building Products, "Ridgemaster Plus" or approved equal.
- B. Soffit vents: Mid-America Building Products, "SoffitMaster" or approved equal.
- C. Substitutions: Under provisions of Section 01600.

2.02 COMPONENTS

- A. Roof Ridge Vents: Formed copolymer of watertight construction. Allows construction below roof membrane to breathe.

- B. Soffit Vents: 6.5 sq. inches of venting area per lineal foot, thickness shall be 1/4" to 1/2".
- C. Pipe Seals: Pipe seals shall flash roof penetrations up to 10" outside diameter. Each unit shall consist of a spun aluminum base having a 5" roof surface flange all around. Stepped PVC boot to be secured to the base and the boot shall be secured to the pipe with adjustable stainless steel clamp.

2.03 ACCESSORIES

- A. Sealants: Specified elsewhere.
- B. Roofing Cement: Compatible with specified shingles and vent.

2.04 FINISHES

- A. Soffit Vents: Formed copolymer with insect proof louver design. Color to be selected by Owner.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify that deck, shingles, flashing, and other items affecting work of this Section are in place and positioned correctly.
- B. Beginning of installation means acceptance of existing conditions.

3.02 INSTALLATION

- A. Install components in accordance with manufacturer's instructions.
- B. Coordinate roofing, shingles and flashings with installation of components of this Section.
- C. Coordinate installation of sealants and roofing cement with work of this Section to ensure watertightness.

END OF SECTION

SECTION 07920

SEALANTS AND CALKING

PART 1 GENERAL

1.01 SUMMARY

- A. Throughout the Work, seal and calk joints where shown on the Drawings and elsewhere as required to provide a positive barrier against passage of moisture and air.

1.02 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are trained and experienced with the specified requirements and the methods needed for proper performance of the work of this Section.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Do not retain at the job site any material which has exceeded the shelf life recommended by the manufacturer.

PART 2 PRODUCTS

2.01 SEALANTS

- A. Provide the following sealants, or equal, where called for on the Drawings or otherwise required for a complete and proper installation.

- 1. Sealant Type A:

- a. One part self-leveling, ASTM C920-79, Grade P, Class 25.
- b. Acceptable products:

- (1) Pecora, Urexpan-201

- c. Uses: Horizontal joists, pool decks, plazas and sidewalks.
- d. Maximum Movement: 25% extension, 25% compression.
- e. Practical Joint Design: 4X expected movement.

- 2. Sealant Type B:

- a. Two-part non-sag, ASTM C920-79, Type S, Grade NS, Class 25.

- b. Acceptable products:
 - (1) Pecora, Dynatrol II.
- c. Uses: Control and expansion joints where extreme structure movement is anticipated.
- d. Maximum Movement: 50% extension, 50% compression.
- e. Practical Joint Design: 4X expected movement.

3. Sealant Type C:

- a. One-part Silicone, Fed Spec TT-S-01543A, Class A.
- b. Acceptable products:
 - (1) Pecora, 864 Silicone.
- c. Uses: Expansion and control joints, in precast panels and metal curtain walls and perimeter sealing.
- d. Maximum Movement: 50% extension, 50% compression.
- e. Practical Joint Design: 4X expected movement.

4. Sealant type D:

- a. Acrylic latex, ASTM C834-76.
- b. Acceptable products:
 - (1) Pecora, AC-20 + Silicone.
- c. Uses: General purpose interior and exterior caulking.
- d. Maximum Movement: 7.5% extension, 7.5% compression.
- e. Practical Joint Design: 12X expected movement.

- B. Colors: Colors for each sealant installation will be selected by the OWNER from standard colors normally available from the specified manufacturer.

2.02 ACCESSORIES

- A. Primer: Non-staining type recommended by sealant manufacturer.
- B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint compounds.
- C. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.02 PREPARATION

- A. Verify that surfaces are ready to receive work and that joint measurements and surface conditions are as recommended by sealant manufacturer.
- B. Remove loose materials and foreign matter which may affect adhesion of sealant.

3.03 INSTALLATION

- A. Clean joints and install sealant in accordance with manufacturer's instructions.
- B. Apply sealant within recommended temperature ranges.
- C. Tool joints concave.

3.04 SEALANT LOCATIONS

- A. Horizontal joints in concrete: Type A.
- B. Control and expansion joints in concrete: Type B.
- C. Interior joints at windows: Type C.
- D. General purpose interior and exterior: Type D.

END OF SECTION

SECTION 08111

FIBERGLASS DOORS, FRAMES AND HARDWARE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fiberglass reinforced plastic doors, frames and stainless steel door hardware.

1.02 SUBMITTALS

- A. Submit under provisions of Section 01340.
- B. Shop Drawings: Indicate door and frame elevations, internal reinforcement, closure method and finish. Indicate locations and mounting heights of each type of hardware.
- C. Product Data: Indicate door and frame configurations, anchor types and spacings, location of cut-outs for each type of hardware, and reinforcement.
- D. Submit manufacturer's parts lists and templates.
- E. Manufacturer's Installation Instructions: Indicate special installation instructions.
- F. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

1.03 QUALITY ASSURANCE

- A. Conform to requirements of ANSI/SDI-100.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum three years documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle Products to site under provisions of Section 01600.
- B. Accept products in manufacturer's packaging. Inspect for damage.
- C. Fiberglass doors shall be stored flat and in a protected environment to prevent warping or discoloration. Damaged doors shall be returned and replaced.

1.06 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on Shop Drawings and as instructed by the manufacturer.

1.07 COORDINATION

- A. Coordinate the Work of this Section with door opening construction.

1.08 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01700.
- B. Include data on operating hardware, lubrication requirements and inspection procedures related to preventative maintenance.

1.09 MAINTENANCE

- A. Furnish under provisions of Section 01700.
- B. Provide special maintenance tools and accessories supplied by hardware component manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Doors and frames shall be Fib-R-Dor manufactured by Advance Fiberglass, Inc., 7516 Counts Massie Road, North Little Rock, Arkansas, 72113, Simon Door, or equal.

2.02 MATERIALS

- A. Doors shall be 1 3/4" thick using end-grain balsa wood as core material. Doors shall be fiberglass reinforced plastic (FRP) using chemically proven resins to achieve the highest performance in any specified environment. Edges shall achieve a finished nominal thickness of 3/8" using a resin and fiberglass matrix. The edge shall consist of 3-5 mats of woven 1.50 ounce fiberglass and resin and shall be molded in one continuous piece. Edges shall be machine tooled for smoothness and accuracy. Extra reinforcement at hinged edge of door shall consist of a 16 gauge steel plate located and matched to the hinge placement. It shall be encapsulated by the resin so as not to be exposed.
- B. Door Plates shall be molded in one continuous piece. Materials consist of premium grade resin reinforced with hand-laid fiberglass mat. Construction of plates shall be nominal 1/8" thick with a gel coated surface of no less than 15 mil to obtain a mirror-like finish of 88 or better per ASTM-D523. A ratio of glass to resin shall be 30% to 70% to maintain superior strength and obtain an R-value of

no less than 11. The specified environmental dictates the type of resins to be used.

- C. Resins: All resins shall be premium grade iso polyester, USDA and FDA approved. If required, fire retardant resins with 3% antimony trioxide can be supplied to produce a flame spread of 25 or less per ASTM-E-84 and shall be self-extinguishing per ASTM-D-635. Vinyl ester resins can be specified for extremely corrosive environments.
- D. Door frame shall conform with S.D.I. specifications and shall be comparable in strength to 16 gauge hollow metal door frame.
- E. Door frames shall be assembled using one piece, FRP pultruded construction with no less than 3/16" in thickness. Frames shall be an industry standard double rabbet 2" face with 5 3/4" profile or single rabbet 2" face with 4" profile. Stops shall cover the edge of the door by no less than 3/8" when in closed position. "Header to Jamb" joints shall be miter cut and assembled by use of FRP clips and stainless steel fasteners. Frames shall also be pigmented to promote true and constant color throughout entire frame thickness. Thresholds shall be of one piece FRP construction. Thresholds shall be of a manner to which threshold may be removed after installation if not required. Frame, upon assembly, shall be one piece in nature and rigid in construction. Manufacturer recommends masonry T-straps or wire straps in new construction applications for ease of installation.

2.03 TRANSOMS

- A. All transoms shall be similar in construction, material, thickness and reinforcement in same manner to that of the door.

2.04 HARDWARE

- A. Hardware hinges shall be stainless steel 4 1/2" x 4 1/2" full mortise, ball bearings applied with stainless steel fasteners. Stainless steel hinges shall be Fib-R-Dor BB51 or equal.
- B. Closers shall be LCN 4041-EDA-SRI-ALVTB for severe service with Norton 1604 SS stainless steel arms.
- C. Kick plates shall be 18 gauge stainless steel with a brushed finish. Edges shall be beveled.
- D. Standard passage and standard lockset ball type door knobs shall use heavy duty series grade 1 stainless steel. Locks for all doors shall be common keyed.
- E. Push/pull sets will be stainless steel in construction and 3 1/2" x 15" size with edges to be beveled.
- F. Exit devices shall be RIM panic 19-R series. Exit devices with pull handle and thumb latch shall be RIM panic 19-RT series or equal.

- G. Note: Hardware, where applicable, such as (closers, locksets, panic devices, etc.) shall be furnished by the same manufacturer unless otherwise noted. The hardware manufacturer's installation instructions shall be enclosed with hardware in original box. The General Contractor shall be ultimately responsible for proper installation of all hardware once received on job site.

PART 3 EXECUTION

3.01 DOOR AND FRAME INSTALLATION

- A. Verify that opening sizes and tolerances are acceptable.
- B. Install doors and frames in accordance with manufacturer's instructions and applicable portions of Steel Door Institute's SDI-100.
- C. Install frames plumb and square. Attach securely to structure before removing spreader bars.
- D. Installer shall not cut or otherwise alter the integrity of the door to allow the door to fit the frame. In such an event, it is recommended that the door be modified at manufacturer's factory.

3.02 HARDWARE INSTALLATION

- A. Verify doors and frames are ready for hardware installation, and dimensions are as indicated on Shop Drawings and instructed by manufacturer.
- B. Install hardware in accordance with manufacturer's instructions.
- C. Use templates provided by door and frame supplier.

3.03 ERECTION TOLERANCES

- A. Doors and Frames Maximum Diagonal Distortion: 1/16 inch measured with straight edge, crossed corner to corner.

3.04 ADJUSTING

- A. Adjust Work under provisions of Section 01700.
- B. Adjust doors and hardware for smooth and balanced operation.

PART 4 GUARANTEE

4.01 CONDITIONS

- A. Manufacturer shall unconditionally guarantee its door for 10 years against failures due to corrosion if the specific environment is named at the time of purchase.

END OF SECTION

SECTION 08645

TRANSPARENT PANELS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Contractor shall furnish and install transparent panel system and glazing.

1.02 SUBMITTALS

- A. Submit each of the following to the Engineer for review at the same time the Shop Drawings are submitted.

1. Each aluminum frame section – 6" long.
2. Samples of aluminum illustrating the specified finish.
3. Glazing gaskets – 6" long – each type.
4. Samples of glazing each minimum 6" x 6" in specified color.
5. Test Data.
6. Product Literature.

B. Shop Drawings

1. Shop drawings shall include plans, elevations, sections and details of the system. Flashings, sealants and anchorage details shall be clearly indicated.
2. Note gauges of frame metals, finishes of frames and hardware and dimensions (if applicable) the work to be performed by other trades.
3. Label fastening devices as to type and spacing.

C. Product Data

1. Submit proposed manufacturer's catalog cuts and specifications to clearly illustrate and describe the submitted transparent panel system.

1.03 QUALITY ASSURANCE

A. Manufacturer

1. The manufacturer for this project must have been regularly engaged for at least five years in the domestic manufacturing of aluminum framed systems of the general type and function as specified and shown in the Contract Drawings.

B. Performance Characteristics

1. The transparent panel system shall meet or exceed the following performance levels relative to the Architectural Aluminum Manufacturer's Association (AAMA) Standard 101.88. Test reports certified by an independent test laboratory based on the testing of a minimum two (2) panels mock-up (with at least one panel having width and length dimensions at least equal to the largest dimensions used on this project) must be presented to the architect.
 - a. Tested in accordance with ASTM E-283, air infiltration shall not exceed 0.03 cubic feet per minute per square foot of panel area when tested at pressure of 12.0 psf.
 - b. The transparent panel system shall not leak when tested in accordance with ASTM E-331 at a test pressure of 12.0 psf.
 - c. When tested in accordance with ASTM E-330, with framing spans and spacings and loading similar to or greater than those required for this project, the maximum deflection of any framing member shall not exceed $L/175$ of its span, and when the load is removed there shall be no evidence of permanent deformation or damage.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the jobsite, in the manufacturer's original and unopened containers and bearing labels as to type of material and manufacturer's name. Delivered materials shall be identical to approved samples.
- B. Store materials under cover in a dry, clean location, off the ground, and remove from the jobsite materials that are damaged or otherwise not suitable for installation and replace it with acceptable materials.

1.05 WARRANTY

- A. The manufacturer shall provide a warranty against defect or malfunction due to workmanship in the equipment and accessories for a period of one year from the date is put into service.
- B. A written warranty shall be supplied.

PART 2 PRODUCTS

2.01 MATERIALS

- A. The transparent panel system shall conform to the following:
 - 1. Framing extrusions shall be 6063-T5, 6005-T5 or 6105-T5 alloy and temper. All sections shall be formed true to detail and free from defects impairing appearance, strength and durability.
 - 2. The rabbet depth at the edges of the framing shall (at an absolute minimum) be based on 3/4" minimum engagement plus 1/8" for cutting tolerance plus $.004 \times$ that glazing dimension (in inches) which affects that rabbet. For example, a 100" long glazing will require a minimum rabbet of $\frac{3}{4}'' + 1/8'' + (.004 \times 100) = 1.275''$. Under no circumstances, even in the coldest possible weather, should panel engagement be less than $\frac{3}{4}''$.
 - 3. Gasketing is to be elastomeric incorporating a low friction coating on the surfaces that contact the glazing. Gasketing shall be tested for chemical compatibility with the glazing, and test reports evidencing desired results shall be presented to the Architect.
 - 4. Fasteners where exposed, shall be stainless steel, 300 Series, with stainless backed neoprene washers. Where not exposed, they may be stainless or cadmium or zinc-plated steel in accordance with ASTM Specification A165-55 or A164-55.
 - 5. Framing members shall be designed so as to handle both leakage water and water from condensation that may form on the inside of the glazing. Leakage and condensation water shall be exhausted at the lower frames.
 - 6. Aluminum framing members (both interior and exterior) shall overlap at the joints to allow for expansion and contraction. They shall be sealed at those joints using a bed of non-shearable sealant (PTI-707 or approved equal) or using foam elastomeric tape. Exposed surfaces framing members on both sides of the glazing shall be mill finish.

7. The system shall provide spacers under the pressure bars so as to cause a controlled pressure of the gasketing against the glazing of four (4) to eight (8) pounds per linear inch. These spacers shall be made of plastic so as to also serve as thermal breaks.
8. The vertical and horizontal framing members shall be positioned at spacings that are acceptable to the manufacturer of the glazing material for the specified load and deflection requirements.
9. The transparent panel system shall be designed as a pressure equalized rain-screen system, so that the pressure inside the system is approximately equal to the atmospheric pressure.
10. Aluminum flashings and other brake metal components shall be minimum .040" thick (thicker where so specified on the drawings). The finish on this metal shall match as closely as possible on the extruded framing members.
11. The glazing panels shall be fixed at the center/bottom. Where panels over 10' in length are used, anti-walk blocks made of low friction material shall be installed at the long sides, maximum 36" on center. These blocks shall restrict sideways movement of the glazing as well as guiding it in its lengthwise thermal motion.
12. Glazing shall be 25 mm cellular polycarbonate sheets, shall be coated with co-extruded factory applied UV-resistant coating and carry the Manufacturer's standard ten (10) year warranty. The glazing shall be clear.
13. The interior cells of the cellular polycarbonate sheets shall be blown clean prior to being sealed. The top of each sheet shall be sealed with a foil tape and the bottom edges shall be sealed with an air permeable tape.
14. The glazing shall rest on a continuous metal setting fin, which is designed to allow atmospheric air to reach the air permeable tape at the bottom of the glazings. Setting blocks, or any other method that would tend to restrict air access, are not acceptable.
15. Glazing shall be installed in accordance with Glazing Manufacturer's guidelines. A representative of The Glazing Manufacturer is to sign the approved shop drawings indicating approval of the general system from the glazing standpoint.

B. Fasteners

1. Bolts, anchors and other fastening devices shall be of approved types as required for the strength of the connections and shall be suitable for conditions encountered. Washers shall be of the same metals as fasteners.
2. Exposed fasteners shall be 300 Series stainless steel and shall utilize stainless steel washers with neoprene seals.
3. Concealed fasteners shall be stainless steel.

C. Metal Protective Materials

1. Tapes, Gaskets, Separators
 - a. Furnish a schedule of all tapes, gaskets, spacers, separators and related items including the designation of areas and specific locations and materials used. Cross reference scheduled items to the shop drawings.

D. Acceptable Transparent Panel Manufacturers

1. EXTECH/Exterior Technologies, Inc. 200 Bridge Street Pittsburgh, PA 15223 (412-781-0991), or approved equal.

2.02 WORKMANSHIP

- A. Carefully and accurately design, fabricate and assemble work with proper provision for contraction and expansion. Work shall be straight, smooth, even and free from defects and shall conform to profiles and sections noted on the shop drawings. Work shall be assembled with joints in a neat and finished manner.
- B. Fasteners: Of strength and spacing sufficient to meet the testing requirements as stated in Section 1.03B and to resist the specified load requirements or code requirements.
- C. Protect contact points between aluminum and dissimilar metals using continuous separators of FRP or PVC tape (or approved equal).

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install the panel framing in a rigid and secure manner using anchoring devices identical to those shown on the approved shop drawings.

- B. Install the system so as to minimize the risk of damage to the surrounding building or the materials of other contractors.
- C. Installation shall be performed by a company with ten (10) years continuous experience in commercial construction.

3.02 PROTECTION AND CLEANING

- A. During installation, protect exposed surfaces against accumulation of paint, caulking, disfiguration and damage.
- B. Interior glazing surface shall be cleaned as it is being installed. The exterior shall be cleaned as each phase of the work is completed and shall be done in strict conformance with methods recommended by the manufacturer.
- C. Before final acceptance, repair and/or replace defective work.

END OF SECTION

SECTION 09900

PAINTING

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Prepare surfaces which are to receive finish.
- B. Finish surfaces as indicated in schedule at end of this Section.
- C. Refer to drawings for other information on locations of finishes.

1.02 QUALITY ASSURANCE

- A. **Manufacturer's Labels:** Include on label or containers manufacturer's name, type of paint, manufacturer's stock number, color, instructions for reducing where applicable, label analysis and FS number.
- B. **Field Quality Control:** Request review of first finished room, space or item of each color scheme for color, texture and workmanship. Use first acceptable room, space or item as project standard for each color scheme. For spray application, paint surface not smaller than 100 SF as project standard.
- C. **Manufacturer's Instructions:** Follow in executing work.
- D. **Field and Shop Coat Compatibility:** To insure satisfactory paint and coating performance, it is a Contract requirement that products applied in the shop and field be mutually compatible.
 - 1. Contractor shall require fabricators and equipment manufacturers to apply shop coats that are compatible with field coats specified herein.
 - 2. Above requirement does not apply to full factory-finished items, this is, items having both primer and final finish coatings, except as otherwise specified in this Section.

1.03 DEFINITIONS

- A. **Definitions of Painting Terms:** ASTM D16, unless otherwise specified.
- B. **Dry Film Thickness (DFT):** Thickness of a coat of cured paint measured in mils (1/1000 inch).

1.04 SUBMITTALS

- A. Submit product data in accordance with Section 01340.
- B. Submit list of manufacturers and products Contractor proposes to use.
- C. Product Data: Submit manufacturer's product data for each coating, including generic description, complete technical data, surface preparation, and application instructions.
- D. Color Samples: Submit manufacturer's color samples showing full range of standard colors.
- E. Manufacturer's Quality Assurance: Submit manufacturer's certification that coatings comply with specified requirements and are suitable for intended application.
- F. Submit applicator's qualifications indicating experience with specified coatings on projects of similar size.

1.05 MAINTENANCE MATERIALS

- A. Leave on premises, acceptably stored, not less than one gallon of each color used.
- B. Containers to be tightly sealed and clearly labeled for identification.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying:
 - 1. Coating or material name.
 - 2. Manufacturer.
 - 3. Color name and number.
 - 4. Batch or lot number.
 - 5. Date of manufacture.
 - 6. Mixing and thinning instructions.
- B. Storage:
 - 1. Store materials in a clean dry area and within temperature range in accordance with manufacturer's instructions.
 - 2. Keep containers sealed until ready for use.
 - 3. Do not use materials beyond manufacturer's shelf life limits.
- C. Take precautionary measures to prevent fire hazards and spontaneous combustions.

1.07 ENVIRONMENTAL CONCERNS

- A. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finished unless moisture contents of surfaces are below following maximums:
 - 1. Plaster and gypsum wallboard: 12%
 - 2. Masonry, concrete and concrete block: 12%, including mortar joints
 - 3. Interior located wood: 15%
 - 4. Exterior located wood: As recommended by manufacturer

- B. Weather:
 - 1. Air and Surface Temperatures: Prepare surfaces and apply and cure coatings within air and surface temperature range in accordance with manufacturer's instructions.
 - 2. Surface Temperature: Minimum of 5 degrees F (3 degrees C) above dew point.
 - 3. Relative Humidity: Prepare surfaces and apply and cure coatings within relative humidity range in accordance with manufacturer's instructions.
 - 4. Precipitation: Do not prepare surfaces or apply coatings in rain, snow, fog, or mist.
 - 5. Wind: Do not spray coatings if wind velocity is above manufacturer's limit.

- C. Ventilation: Provide ventilation during coating evaporation stage in confined or enclosed areas in accordance with AWWA D 102.

- D. Dust and Contaminants:
 - 1. Schedule coating work to avoid excessive dust and airborne contaminants.
 - 2. Protect work areas from excessive dust and airborne contaminants during coating application and curing.

- E. Provide minimum 15 foot candles of lighting on surfaces to be finished.

1.08

PROTECTION

- A. Adequately protect other surfaces from paint and damage. Repair damage as a result of inadequate or unsuitable protection.
- B. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted and, in particular, surfaces within storage and preparation area.
- C. Place cotton waste, cloths and material which may constitute a fire hazard in closed metal containers and remove daily from site.
- D. Remove electrical plates, surface hardware, fittings and fastenings, prior to painting operations. These items are to be carefully stored, cleaned and replaced on completion of work in each area. Do not use solvent to clean hardware that may remove permanent lacquer finish.

1.09 SCHEDULING AND COORDINATION

- A. Coordinate the delivery and installation of the Work of the Section with the Work of other Sections.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Products of The Sherwin-Williams Company have been listed to establish a standard of product formulation and quality.
- B. Equal products of the following manufacturers are approved:

Benjamin Moore
 Pennsbury
 DuPont

2.02 MATERIALS

- A. Materials furnished shall be by manufacturers listed and shall comply with all requirements of the specifications.
- B. Select products from description of systems which follows.
- C. Select all primary products of a coating system from the products of a single manufacturer.
- D. Secondary products not specified by name and required for the job shall be "best grade" or first line" products of a reputable manufacturer.

- 2.03 COLORS
- A. Colors shall be in accordance with the Recommended Standards for Water Works and as listed in the Color Schedule.
 - B. Colors of paints, including shades of stain, shall match color samples approved by the Engineer.
- 2.04 MIXING AND TINTING
- A. Deliver paints and enamels ready-mixed to jobsite.
 - B. Accomplish job mixing and job tinting only when acceptable to Engineer.
 - C. Mix only in mixing pails placed in suitable sized non-ferrous or oxide resistant metal pans.
 - D. Use tinting colors recommended by manufacturer for the specific type of finish.
- 2.05 COATING SYSTEMS FOR STEEL – STRUCTURAL, TANKS, PIPE, EQUIPMENT, AND MISCELLANEOUS (See exceptions in paragraph 3.14)
- A. Exterior Exposed:
 - 1. System Type: Epoxy*/epoxy/urethane.
 - 2. Surface Preparation: SSPC-SP 6.
 - 3. Primer*: Macropoxy 646. DFT 3.0 to 5.0 mils.
 - 4. Intermediate Coat: Macropoxy 646. DFT 3.0 to 5.0 mils.
 - 5. Finish Coat: Acrolon 218HS or Hi-Solids Polyurethane. DFT 3.0 to 5.0 mils.
 - 6. Total DFT: 9.0 to 15.0 mils.
 - 7. Finish Color: As indicated in 2.03A.
 - * Copoly Shop Primer and Corothane I Galvapak Zinc Primer are also acceptable.
 - B. Interior Exposed:
 - 1. System Type: Epoxy*/dpoxy/epoxy.
 - 2. Surface Preparation: SSPC-SP 6.
 - 3. Primer*: Macropoxy 646. DFT 3.0 to 5.0 mils.
 - 4. Intermediate Coat: Macropoxy 646. DFT 3.0 to 5.0 mils.
 - 5. Finish Coat: Macropoxy 646. DFT 3.0 to 5.0 mils.
 - 6. Total DFT: 9.0 to 15.0 mils.
 - 7. Finish Color: As indicated in 2.03A.
 - * Copoly Shop Primer and Corothane 1 Galvapak Zinc Primer are also acceptable.
 - C. Immersion:
 - 1. System Type: Epoxy*/epoxy/epoxy.

2. Surface Preparation: SSPC-SP 10.
 3. Primer*: Macropoxy 646 PW. DFT 3.0 to 5.0 mils.
 4. Intermediate Coat: Macropoxy 646 PW. DFT 4.0 to 6.0 mils.
 5. Finish Coat: Macropoxy 646 PW. DFT 5.0 to 7.0 mils.
 6. Total DFT: 12.0 to 18.0 mils.**
7. Finish Color: As indicated in 2.03A.
- * Copoxy Shop Primer and Corothane I Galvapac Zinc Primer are also acceptable.
- ** Spray apply Dura-Plate UHS or SherPlate PW for one or two coat application.

2.06 COATING SYSTEMS FOR GALVASNIZED STEEL AND NONFERROUS METAL – PIPE AND MISCELLANEOUS FABRICATIONS

- A. Exterior Exposed:
1. System Type: Epoxy/urethane.
 2. Surface Preparation: SSPC-SP 16
 3. Primer: Macropoxy 646. DFT 3.0 to 5.0 mils.
 4. Finish Coat: Acrolon 218HS or Hi-Solids Polyurethane. DFT 3.0 to 5.0 mils.
 5. Total DFT: 6.0 to 10.0 mils.
 6. Finish Color: As indicated in 2.03A.
- B. Interior Exposed:
1. System Type: Epoxy.
 2. Surface Preparation: SSPC-SP 16
 3. Primer: Macropoxy 646. DFT 3.0 to 5.0 mils.
 4. Finish Coat: Macropoxy 646. DFT 3.0 to 5.0 mils.
 5. Total DFT: 6.0 to 10.0 mils.
 6. Finish Color: As indicated in 2.03A.
- C. Immersion:
1. System Type: Epoxy/epoxy.
 2. Surface Preparation: SSPC-SP 16
 3. Primer Coat: Macropoxy 646 PW. DFT 3.0 to 5.0 mils.
 4. Finish Coat: Macropoxy 646 PW. DFT 5.0 to 7.0 mils.
 5. Total DFT: 8.0 to 12.0 mils.

2.07 COATING SYSTEMS FOR DUCTILE OR CAST IRON – PIPE, PUMPS, AND VALVES

- A. Exterior Exposed:
1. System Type: Epoxy*/epoxy/urethane.
 2. Surface Preparation: NAPF 500-03-03 Power Tool Cleaning.
 3. Primer: Macropoxy 646. DFT 3.0 to 5.0 mils.

4. Intermediate Coat: Macropoxy 646. DFT 3.0 to 5.0 mils.
5. Finish Coat: Acrolon 218HS or Hi-Solids Polyurethane. DFT 3.0 to 5.0 mils.
6. Total DFT: 9.0 to 15.0 mils.
7. Finish Color: As indicated in 2.03A.
- * Copoxy Shop Primer and Corothane 1 Galvapak Zinc Primer are also acceptable.

B. Below Ground (Buried):

1. System Type: Coal tar epoxy.
2. Surface Preparation: NAPF 500-03-04 Abrasive Blast Cleaning.
3. Primer: None.
4. Finish Coat: Hi-Mil Sher-Tar Epoxy. DFT 14.0 to 20.0 mils.
5. Total DFT: 14.0 to 20.0 mils.
6. Finish Color: Black.

C. Interior Exposed:

1. System Type: Epoxy*/epoxy/epoxy.
2. Surface Preparation: Surface Preparation: NAPF 500-03-03 Power Tool Cleaning.
3. Primer: Macropoxy 646. DFT 3.0 to 5.0 mils.
4. Intermediate Coat: Macropoxy 646. DFT 3.0 to 5.0 mils.
5. Finish Coat: Macropoxy 646. DFT 3.0 to 5.0 mils.
6. Total DFT: 0.0 to 15.0 mils.
7. Finish Color: As indicated in 2.03A.
- * Copoxy Shop Primer and Corothane I Galvapak Zinc Primer are also acceptable.

D. Immersion:

1. System Type: Epoxy*/epoxy/epoxy.
2. Surface Preparation: NAPF 500-03-04 Abrasive Blast Cleaning.
3. Primer*: Macropoxy 646 PW. DFT 3.0 to 5.0 mils.
4. Intermediate Coat: Macropoxy 646 PW. DFT 4.0 to 6.0 mils.
5. Finish Coat: Macropoxy 646 PW. DFT 5.0 to 7.0 mils.
6. Total DFT: 12.0 to 18.0 mils.
- * Copoxy Shop Primer and Corothane I Galvapak Zinc Primer are also acceptable.

2.08 COATING SYSTEMS FOR PVC OR CPVC

A. Exterior Exposed:

1. System Type: Epoxy/urethane.
2. Surface Preparation: Scarify.
3. Primer: Macropoxy 646. DFT 3.0 to 5.0 mils.
4. Finish Coat: Acrolon 218HS or Hi-Solids Polyurethane. DFT 3.0 to 5.0 mils.
5. Total DFT: 6.0 to 10.0 mils.
6. Finish Color: As indicated in 2.03A.

- B. Interior Exposed:
1. System Type: Epoxy.
 2. Surface Preparation: Scarify
 3. Primer: Macropoxy 646. DFT 3.0 to 5.0 mils.
 4. Finish Coat: Macropoxy 646. DFT 3.0 to 5.0 mils.
 5. Total DFT: 6.0 to 10.0 mils.
 6. Finish Color: As indicated in 2.03A.

2.09 COATING SYSTEMS FOR INSULATED PIPE

- A. Interior/Exterior Exposed:
1. System Type: Acrylic
 2. Surface Preparation: Clean and dry.
 3. Primer: DTM Acrylic. DFT 2.5 to 4.0 mils.
 4. Finish Coat: DTM Acrylic. DFT 2.5 to 4.0 mils
 5. Total DFT: 5.0 to 8.0 mils.
 6. Finish Color: As indicated in 2.03A.

2.10 COATING SYSTEMS FOR PRECAST CONCRETE, CAST-IN-PLACE CONCRETE, AND DENSE CONCRETE MASONRY UNITS

- A. Exterior Exposed:
1. System Type: Elastomeric Acrylic
 2. Surface Preparation: SSPC-SP 13/NACE 6 to achieve a surface profile of ICRI CSP 2 or 3. Clean and dry.
 3. Primer: Loxon XP. Spreading Rate – 90 to 115 sf/gal.
 4. Finish Coat: Loxon XP. Spreading Rate – 90 to 115 sf/gal.
- B. Below Grade (Soil Side):
1. System Type: Coal tar epoxy.
 2. Surface Preparation: SSPC-SP 13/NACE 6 to achieve a surface profile of ICRI CSP 2 or 3. Clean and dry.
 3. Primer: None.
 4. Finish Coat: Hi-Mil Sher-Tar Epoxy. DFT 14.0 to 20.0 mils.
 5. Total DFT: 14.0 to 20.0 mils.
- C. Immersion:
1. System Type: Epoxy.
 2. Surface Preparation: SSPC-SP 13/NACE 6 to achieve a surface profile of ICRI CSP 2 or 3.
 3. Primer: Macropoxy 646 PW. DFT 3.0 to 5.0 mils. Roll or backroll.
 4. Intermediate Coat: Macropoxy 646 PW. DFT 4.0 to 6.0 mils.
 5. Finish: Macropoxy 646 PW. DFT 5.0 to 7.0 mils.
 6. Total DFT: 12.0 to 18.0 mils.
 7. Finish Color: As indicated on the drawings, or color schedule.

** Spray apply Dura-Plate UHS for two coat application.

- D. Interior Exposed:
1. System Type: Epoxy [Spray apply, or addition coats may be required].
 2. Surface Preparation: SSPC-SP 13/NACE 6 to achieve a surface profile of ICRI CSP 2 or 3.
 3. Primer: Pro-Industrial Hi-Bild Waterbased Catalyzed Epoxy. DFT 4.0 to 6.0 mils. Roll or backroll.
 4. Finish Coat: Pro-Industrial Hi-Bild Waterbased Catalyzed Epoxy. DFT 4.0 to 6.0 mils.
 5. Total DFT: 8.0 to 12.0 mils.

2.11 COATING SYSTEMS FOR POROUS CONCRETE MASONRY UNITS

- A. Exterior Exposed:
1. System Type: Elastomeric Acrylic.
 2. Surface Preparation: SSPC-SP 13/NACE 6. Clean and dry.
 3. Primer: Loxon XP. Spreading Rate – 90-115 sf/gal.
 4. Finish Coat: Loxon XP. Spreading Rate – 90- 115 sf/gal.
 5. Finish Color: As selected by Owner from manufacturer’s standard colors.
- B. Interior Exposed:
1. System Type: Cementious Acrylic/epoxy.
 2. Surface Preparation: SSPC-SP 13/NACE 6. Clean and dry.
 3. Primer: Cement Plex 875. DFT 13.0 to 25.0 mils.
 4. Intermediate Coat: Pro-Industrial Hi-Bild Waterbased Catlyzed Epoxy. DFT 4.0 to 6.0 mils.
 5. Finish Coat: Pro-Industrial Hi-Bild Waterbased Catalyzed Epoxy. DFT 4.0 to 6.0 mils.
 6. Total DFT: 8. To 12.0 mils plus filler.
 7. Finish Color: As selected by Owner from manufacturer’s standard colors.

2.12 COATING SYSTEMS FOR PLASTER, GYPSUM BOARD, AND WOOD

- A. Interior Exposed:
1. System Type: Latex/acrylic-epoxy.
 2. Surface Preparation: Clean and dry.
 3. Primer: Multi-Purpose Latex Primer. DFT 1.0 to 1.5 mils.
 4. Intermediate Coat: Pro-Industrial Hi-Bild Waterbased Catalyzed Epoxy. DFT 2.0 to 3.0 mils.
 5. Finish Coat: Pro-Industrial Hi-Bild Waterbased Catalyzed Epoxy. DFT 2.0 to 3.0 mils.

6. Total DFT: 5.0 to 7.5 mils.
7. Finish Color: As selected by owner from manufacturer's standard colors.

2.13 ACCESSORIES

A. Coating Application Accessories:

1. Accessories required for application of specified coatings in accordance with manufacturer's instructions, including thinners.
2. Products of coating manufacturer.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine surfaces scheduled to receive paint and finishes for conditions that will adversely affect execution, permanence or quality of work and which cannot be corrected to an acceptable condition using preparatory work described in Preparation of Surfaces.
- B. Do not proceed with surface preparation or coating application until conditions are suitable.

3.02 PREPARATION OF SURFACES NOT SCHEDULED TO BE COATED

- A. Protect surrounding areas and surfaces not schedule to be coated from damage during surface preparation and application of coatings.
- B. Immediately remove coatings that fall on surrounding areas and surfaces not scheduled to be coated.

3.03 SURFACE PREPARATION OF STEEL

- A. Prepare steel surfaces in accordance with manufacturer's instructions.
- B. Fabrication Defects:
 1. Correct steel and fabrication defects revealed by surface preparation.
 2. Remove weld spatter and slog.
 3. Round sharp edges and corners of welds to a smooth contour.
 4. Smooth weld undercuts and recesses.
 5. Grind down porous welds to pinhole-free metal.

- 6. Remove weld flux from surface.
 - C. Ensure surfaces are dry.
 - D. Immersion or Below Grade Surfaces: Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 10/NACE 2. Create a blast profile of 1.5 to 2.5 mils.
 - E. Exterior Exposed or Interior Exposed Surfaces: Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 6/NACE 3. Create a blast profile of 1.5 to 2.5 mils.
 - F. Abrasive Blast-Cleaned Surfaces: Coat abrasive blast-cleaned surfaces with primer before visible rust forms on surface. Do not leave blast-cleaned surfaces uncoated for more than 8 hours.
 - G. Shop Primer: Shop primed steel shall receive a field sweep blast prior to the application of subsequent coats. Prepare shop primer to receive field coat in accordance with manufacturer's instructions. Removal all unknown shop primers and re-prime in accordance with this specification.
- 3.04 SURFACE PREPARATION OF GALVANIZED STEEL AND NONFERROUS METAL
- A. Prepare galvanized steel and nonferrous metal surfaces in accordance with SSPC-SP 16 and the coating manufacturers instructions.
 - B. Check for post treatment of galvanizing using a copper sulfate solution in accordance with ASTM B201.
 - C. Ensure surfaces are dry.
- 3.05 SURFACE PREPARATION OF DUCTILE OR CAST IRON
- A. Prepare ductile or cast iron surfaces in accordance with NAPF 500-03-04 Abrasive Blast Cleaning or NAPF 500-03-03 Power Tool Cleaning and the coating manufacturer's instruction.
 - B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.
- 3.06 SURFACE PREPARATION OF PVC OR CPVC
- A. Prepare PVC surfaces in accordance with manufacturer's instructions.

- B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.
- C. Scarify surfaces.

3.07 SURFACE PREPARATION OF CONCRETE

A. Interior, Wet Substrate:

1. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 310.2.
2. Allow concrete to cure for a minimum of 28 days.
3. Test concrete for moisture in accordance with ASTM D4263 and, if necessary, F 1869.
4. Abrasive blast surface to remove laitance and solid contaminants and to provide clean, sound substrate with uniform anchor profile.
5. Verify that the pH of the cleaned concrete surfaces to be coated is within the range of 8 to 11. Application of coating materials outside this range will not be permitted without written approval from the Engineer.
6. Fill holes, pits, voids, and cracks with manufacturer approved surfacer.
7. Ensure surfaces are clean, dry, and free of oil, grease, chalk, form release agents, and other contaminants.

B. Exterior and Interior Dry:

1. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 310.2.
2. Allow concrete to cure for a minimum of 14 days.
3. Test concrete for moisture in accordance with ASTM D 4263 and, if necessary, F 1869.
4. Level concrete protrusions and mortar spatter.
5. Verify that the pH of the cleaned concrete surfaces to be coated is within the range to 8 to 11. Application of coating materials outside this range will not be permitted without written approval from the Engineer.
6. Fill hairline cracks less than 1/64 inch (0.4 mm) in accordance with manufacturer's instructions.
7. Prepare cracks wider than 1/64 inch (0.4 mm), moving cracks, gaps, and expansion joints in accordance with manufacturer's instructions.
8. Ensure surfaces are clean, dry, and free of oil, grease, chalk, form release agents, and other contaminants.

3.08 SURFACE PREPARATION OF POROUS CONCRETE MASONRY UNITS

- A. Prepare porous concrete masonry unit surfaces in accordance with manufacturer's instructions and SSPC-SP 13/NACE 6.

- B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.
- C. Allow mortar to cure for a minimum of 28 days before coating.
- D. Level protrusions and mortar spatter.

3.09 SURFACE PREPARATION OF GYPSUM BOARD

- A. Prepare gypsum board surfaces in accordance with manufacturer's instructions.
- B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.
- C. Sand joint compound smooth and feather edge.
- D. Avoid heavy sanding of adjacent gypsum board surfaces, which will raise nap of paper covering.
- E. Do not apply putty, patching pencils, caulking, or masking tape to drywall surfaces to be painted.
- F. Lightly scuff-sand tape joints after priming to remove raised paper nap. Do not sand through primer.

3.10 SURFACE PREPARATION OF WOOD

- A. Prepare wood surfaces in accordance with manufacturer's instructions.
- B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, surface deposits of sap or pitch, and other contaminants.
- C. Seal knots and pitch pockets.
- D. Sand rough spots with the grain.
- E. Fill cracks and holes with approved materials after primer is dry. Sand flush with surface when filler is hard.
- F. Lightly sand between coats.

3.11 APPLICATION

- A. Apply coatings in accordance with manufacturer's instructions.

- B. Mix and thin coatings, including multi-component materials, in accordance with manufacturer's instructions.
- C. Keep containers closed when not in use to avoid contamination.
- D. Do not use mixed coatings beyond pot life limits.
- E. Use application equipment, tools, pressure settings, and techniques in accordance with manufacturer's instructions.
- F. Uniformly apply coatings at spreading rate required to achieve specified DFT.
- G. Apply coatings to be free of film characteristics or defects that would adversely affect performance or appearance of coating systems.
- H. Stripe paint with brush critical locations on steel such as welds, corners, and edges using specified primer. Apply and additional strip coat of the intermediate coating material in immersion areas.
- I. Roll or backroll the first coat of epoxy or block filler applied to concrete or interior block substrates to work the material into the substrate.

3.12 INTERFACE WITH OTHER WORK

- A. Refer to mechanical and electrical sections with respect to factory made identification banding and labeling of equipment, ducting, piping and conduit.
- B. Remove prime coated grilles, covers and access panels for mechanical and electrical systems from location and paint separately.
- C. Finish paint primed equipment to color selected.
- D. Where exposed to view in spaces otherwise scheduled to be painted, prime and paint insulated and bare pipes, equipment, conduits, boxes, insulated and bare ducts, hangers, brackets, collars and supports, except where items are factory painted, plated or covered with a pre-finished coating.
- E. Replace identification markings on mechanical or electrical equipment when painted over or spattered.
- F. Paint interior surfaces of air duct, convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint, to limit of sight line. Paint dampers exposed immediately behind louvers, grilles, convector and baseboard cabinets to match face panels.

- G. Paint both sides and edges of any plywood backboards for electrical equipment before installing backboards and mounting equipment on them.
- H. Color code equipment, piping, conduit and exposed ductwork in accordance with requirements indicated on color schedule to be used by the Engineer.
- I. Paint all non-aluminum exposed conduit and mechanical ductwork, pipes, stacks, equipment and supports above the roof level or outside the building.

3.13 CLEANING

- A. As work proceeds and upon completion, promptly remove paint where spilled, splashed or spattered.
- B. During progress of work keep premises free from any unnecessary accumulation of tools, equipment, surplus materials and debris.
- C. Upon completion of work leave premises neat and clean, to the satisfaction of Engineer.

3.14 SURFACES NOT TO BE PAINTED UNDER THIS SECTION

- A. Structural steel and steel joists concealed from view.
- B. Stone.
- C. Prefinished wall, ceiling and floor coverings.
- D. Prefinished cabinet work.
- E. Items of equipment having factory applied final finish (other than prime coat).
- F. Concealed ductwork (except as noted).
- G. Concealed conduits (except as noted).
- H. Concealed pipe insulation (except as noted).
- I. Aluminum, stainless steel, glass, chrome, siding, Fiberglass doors and frames, and pressure treated wood.

3.15 SCHEDULE – COLORS

- A. Conduits - OSHA Orange
- B. Raw Water Pipe - Olive Green

- | | | | |
|----|-------------------------|---|---------------------------|
| C. | Potable Water Pipe | - | Dark Blue |
| D. | Walls & Ceiling | - | White |
| E. | Pumps | - | Manufacturer's Stds. |
| F. | Sewer Piping & Fittings | - | Gray |
| G. | Other Interior Metals | - | To be selected by Owner |
| H. | Exterior Metals | - | To be selected by Owner |
| I. | Siding, trim, doors | - | To be selected by Owner |
| J. | Chlorine Solution | - | Yellow |
| K. | NaF piping | - | Light Blue with Red Bands |

END OF SECTION

SECTION 11000

EQUIPMENT GENERAL PROVISIONS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. General provisions describe requirements for all equipment specified in Division 11.

1.02 SUBMITTALS

- A. Shop Drawings: Submit completely dimensioned drawings in plan and cross section as required to provide a complete description of system equipment specified in Sections of Division 11. Shop drawings shall be certified for construction by the manufacturer and approved by the Contractor. Include location of electrical connections and characteristics; wiring diagrams; utility requirements as to types, sizes and locations; anchor bolt layout; mounting requirements and clearances; details indicating construction, assembly views, and materials of construction; diameter of shafting; dimensions and rated horsepower of all motors; gear and bearing ratings; service factors and weights of principal parts and completely assembly equipment.
- B. Product Data: Submit performance data including pump curves; equipment capacities, characteristics and limitations; materials of construction; finishes.
- C. Manufacturer's Installation Instructions: Indicate installation requirements and special procedures. Provide equipment preparation and start-up procedures.

1.03 QUALITY ASSURANCE

- A. Perform work in accordance with Section 01400.

1.04 OPERATION AND MAINTENANCE DATA

- A. Submit to the Engineer for review and approval, five copies of manuals prepared by the manufacturer/suppliers, or the Contractor within four weeks following the receipt of accepted shop drawings. The submission and approval of each set of manuals will be considered to be an integral part of furnishing and installation of the respective equipment or system. The Contractor will be informed if manuals submitted are incomplete or require revision. Contractor shall supply the information necessary for completion.

- B. Include the following elements in each manual:
1. Erection or installation instructions.
 2. Start-up procedures.
 3. Recommended and alternative procedures.
 4. Troubleshooting guide.
 5. Schedule of preventative maintenance requirements.
 6. Replacement parts list and schedule of recommended spare parts to be stocked, complete with part number, inventory quantity and ordering information.
 7. Detailed maintenance procedures.
 8. Schedule of lubrication requirements.
 9. Corrected and approved control and wiring diagrams.
 10. Data sheet listing pertinent equipment or system information.
 11. Addresses and telephone numbers of the nearest sales and service representatives.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver, handle and protect products in accordance with manufacturer's recommendations.
- B. When unloading materials, equipment, and machinery, provide special lifting harness or apparatus as may be required by manufacturers. Handle materials, equipment and machinery in accordance with manufacturer's written instructions.
- C. Store materials, equipment and machinery, both on and off site, in accordance with manufacturer's written instructions.
- D. When transporting materials, equipment and machinery, both on site and from Contractor's storage to the site, do so in accordance with recommendations of the respective manufacturers of each.

1.06 SCHEDULING AND COORDINATION

- A. Coordinate the delivery and installation of equipment specified in this Division with the Work of other sections.
- B. Electrical Interface: Install or mount, as work of this Contract, those electrical components or apparatus as furnished by the Products specified in this Division.

- C. Field and Shop Coat Compatibility: To insure satisfactory paint and coating performance, products applied in the shop and field must be mutually compatible.
- D. Start-up and testing: Coordinate start-up and testing with work of other sections and ensure that required utilities and water supply are available.

1.07 WARRANTY

- A. The manufacturer shall provide a warranty against any defect or malfunction due to workmanship in the equipment and accessories for a minimum period of one year from date of final acceptance for installed demonstrated system unless otherwise stated in individual specification sections.
- B. A written manufacturer's warranty shall be supplied.

1.08 PROJECT RECORD DOCUMENTS

- A. Record actual locations of pipes, utilities, equipment and accessories.

1.09 GENERAL INSTALLATION REQUIREMENTS

- A. The Contractor shall check all dimensions indicated immediately after award of the Contract. Advise the Engineer promptly of any discrepancies or interferences and obtain such measurements and information as may be required to satisfactorily install the work.
- B. Before ordering any material or doing any work, the Contractor shall verify all measurements and elevations and shall be responsible for the correctness of same. Any difference which may be found between field measurements and elevations and those indicated shall be promptly submitted to the Engineer for adjustment and approval before proceeding with the work.
- C. Verify that site conditions are ready to receive the work.
- D. The Contractor shall lay out work and establish heights and grades in strict accordance with the Drawings, the building and finished site grades, and shall be responsible for the accuracy of such layout.
- E. Verify that required utilities are available and of the correct characteristics.
- F. Align, level and adjust equipment for satisfactory operation: install so that connecting and disconnecting of piping and accessories can be done readily, and so that all parts are easily accessible for inspection, operation and maintenance.

- G. Material and equipment shall be installed in accordance with manufacturers' written instructions and recommendations.
- H. Manufacturer's representative shall review equipment installation and provide written certification that equipment and its installation meet manufacturer's recommendations and comply with the Specifications.

1.10 EQUIPMENT DEMONSTRATION

- A. Contractor shall furnish all labor, tools, materials, equipment and water for all demonstration tests.
- B. Operation of equipment during all phases of demonstration prior to Final Acceptance by Owner and Engineer is the Contractor's complete responsibility.
- C. Notify Engineer and Owner seven days in advance of each test or demonstration.
- D. Initial equipment start-up: After manufacturer's representative has reviewed the installation of his equipment and found it acceptable, he shall place equipment in operation. He shall perform all tests necessary to ensure each item of equipment operates in accordance with the design intent and Specifications. At a minimum the following tests are required and must be performed in the presence of the Engineer:
 - 1. Starting current
 - 2. Running current
 - 3. Demonstration of accuracy of gauges.
 - 4. Demonstrate valves are in working condition.
- E. Correction of deficiencies - All performance deficiencies, leaks, misalignments found during start-up shall be corrected at Contractor's expense. Correction may include replacement of defective equipment if Engineer so recommends. Correction must be performed and accepted by Engineer prior to remaining demonstrations.
- F. Mechanical Performance Test: When individual items of equipment have been shown to operate satisfactorily to Owner and Engineer, Contractor shall operate all equipment together as a system using water as process flow. Contractor shall test all performance functions, all alternate and emergency operating procedures and all alarm conditions using actual or simulated conditions. Contractor shall coordinate test to ensure all required manufacturer's representatives and subcontractors are present. Each manufacturer's representative shall ensure that

his equipment is performing as intended. All deficiencies shall be corrected at Contractor's expense.

- G. Successful Demonstration: When all equipment components perform individually and as an integrated whole according to the design intent and as specified and all deficiencies have been permanently corrected. The Mechanical Performance Demonstration shall be considered successful.
- H. Repeat Demonstration: When defects are encountered, repeat Demonstration after corrective actions have been taken. Continue this process until no defects are encountered.

1.11 MANUFACTURER'S REPRESENTATIVE

- A. Provide services of a qualified equipment manufacturer's representative to review installation, perform pre-start-up checks, start-up, test, adjust and demonstrate equipment and instruct Owner in operation and maintenance procedures.
- B. Instruction for Owner shall not be scheduled until Initial mechanical Performance Demonstration has been successfully completed.
- C. Instruction for Owner shall include review of start-up, operation and shut down procedures, alternate modes of operation, anticipated adjustments, maintenance procedures and schedules, troubleshooting methods and manufacturer's operation and maintenance literature. Owner reserves right to videotape instruction sessions.
- D. Manufacturer's Representative shall certify in writing that installation is satisfactory and that equipment is operating as specified.
- E. Furnish services of Manufacturer's Representative for the minimum period of time indicated in the following table for each item of equipment. Times indicated shall not include travel time. If correction of deficiencies and retesting requires more than the indicated time, Contractor shall extend time at no additional cost to Owner. Time period for instruction of Owner is also indicated. This minimum time for instruction shall be provided irrespective of hours provided for start-up, testing, correction of deficiencies and demonstrations. Time spent in these other activities will not be considered training hours.

		Non-Instruction Hours	Instruction Hours
1.	Flow Meter	-	2
2.	Metering Pumps	-	2
3.	Fluorosilicic Equipment	-	2
4.	Chart Recorder	-	2
5.	PH/Chlorine/Fluoride Analyzer	-	2
6.	Auto Control Valves	-	2
7.	Chlorination Equipment	-	2

F. Training and start-up of electrical and control equipment is specified elsewhere.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

No Used

END OF SECTION

SECTION 11210

PUMPS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. The Contractor shall furnish and install pumps, appurtenances, and accessories indicated on the Drawings and specified herein. Spare parts shall be included.
- B. Pumps in this section include the decant pumps and the Return Activated Sludge (RAS) pumps. All controls are by others.

1.02 SUBMITTALS

- A. Submit under the provisions of Section 01340.
- B. Shop Drawings: Indicate in large scale detail, fabricated equipment showing construction methods and locations in plan and cross section, mounting requirements and clearances, and utility requirements as to types, sizes and locations. For control system, indicate service connections, characteristics and wiring diagrams.
- C. Product Data: Provide equipment dimensions and construction, equipment capacities, pump curves, characteristics and limitations, materials, finishes, utility requirements and locations.
- D. Manufacturer's Installation Instructions: Indicate installation requirements and special procedures.
- E. Certified copies of factory run pump performance tests.

1.03 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01700.
- B. Operation Data: Provide operating data for specified equipment.
- C. Maintenance Data: Provide lubrication and periodic maintenance requirements and schedules.

1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with Section 01400.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle equipment according to manufacturer's instructions and the provisions of Section 01600.

1.06 SCHEDULING AND COORDINATION

- A. Schedule Work under the provisions of Section 01310.
- B. Coordinate the delivery and installation of the Work of this Section with the Work of other Sections.

1.07 WARRANTY

- A. The manufacturer shall provide a warranty against any defect or malfunction due to workmanship in the equipment and accessories for a period of one year from the date the system is put into service.
- B. A written manufacturer's warranty shall be supplied.

1.08 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01700.
- B. Record actual locations of pipes, utilities, equipment and accessories.

1.09 MANUFACTURER'S REPRESENTATIVE

- A. Furnish the services of a qualified equipment manufacturer's representative for a minimum of one 8 hour day after equipment installation for testing, start-up, and correction of deficiencies for each pump system. Four (4) hours shall be provided for Owner instruction for each pump system. Should correction of deficiencies require additional days, provide manufacturer's representative's time, at no additional cost to Owner until system performs as specified.

PART 2 PRODUCTS

2.01 SUBMERSIBLE TYPE PUMPS

- A. General
 - 1. Furnish and install a total of two (2) cast iron submersible non-clog pumps by Xylem Flygt or approved equal. See electrical specifications for pump controls.

<u>Name</u>	<u>Quantity</u>	<u>Model No.</u>	<u>Impeller</u>	<u>Capacity</u>	<u>Driver</u>
Decant Pumps	2	NS 3085	466	250GPM @ 25'	3HP,460V,3Ø

3. The decant pumps shall be piped to discharge through a hose and shall be suspended from a hoist as shown on the drawings.
4. Major pump components shall be of grey cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts or bolts shall be AISI type 304 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.
5. 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 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.
6. Motors are sufficiently cooled by the surrounding environment or pumped media. A water jacket is not required.
7. The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate the interior from foreign material gaining access through the pump top.

B. Drivers

1. Drive motors: shall have the following options:
 - a. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housing in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using

Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be designed for continuous duty handling pumped media of 40°C (104°F) and capable of up to 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches set to open at 125°C (260°F) shall be embedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber containing the terminal board, shall be hermetically sealed from the motor by an elastomer compression seal. Connection between the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board. The motor and the pump shall be produced by the same manufacturer.

- b. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40°C (104°F) ambient and with a temperature rise not to exceed 80°C. A performance chart shall be provided showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics.
- c. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet.
- d. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.
- e. The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated. The upper bearing shall be a single deep groove ball bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces. Single row lower bearings are not acceptable.
- f. Each pump shall be provided with a tandem mechanical shaft seal

system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating, corrosion resistant tungsten-carbide ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary and one positively driven rotating, corrosion resistant tungsten-carbide seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction of rotation for sealing. The position of both mechanical seals shall depend on the shaft. Mounting of the lower mechanical seal on the impeller hub will not be acceptable.

- g. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. The motor shall be able to operate dry without damage while pumping under load.
- h. Seal lubricant shall be FDA Approved, nontoxic.
- i. Pump and motor shaft shall be the same unit. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The shaft shall be AISI type 431 stainless steel.
- j. The impeller(s) shall be of gray cast iron, Class 35B, dynamically balanced, double shrouded non-clogging design having a long throughlet without acute turns. The impeller(s) shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in wastewater. A full vaned impeller shall be used for maximum hydraulic efficiency. Impeller(s) shall be keyed to the shaft, retained with an Allen head bolt. All impellers shall be coated with an acrylic dispersion zinc phosphate primer.
- k. A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impeller. Each pump shall be equipped with a brass, or nitrile rubber coated steel ring insert that is drive fitted to the volute inlet.
- l. Pump volutes(s) shall be single-piece grey cast iron, Class 35B, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified.

- m. All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. The thermal switches shall open at 125°C (260°F), stop the motor and activate an alarm.
- n. A leakage sensor shall detect water in the stator chamber. The Float Leakage Sensor (FLS) is a small float switch used to detect the presence of water in the stator chamber. When activated, the FLS will stop the motor and send an alarm both local and/or remote.
- o. The thermal switches and FLS shall be connected to a Mini CAS (Control and Status) monitoring unit. The Mini CAS shall be provided loose for field installation in the pump's motor control circuit.

C. Pump Accessories

- 1. The decant pumps shall be suspended by a SS cable attached to the pump's hoist, and shall have built in floats to turn off the pumps at low water levels.

2.02 DOUBLE DISC PUMPS

A. General

- 1. Furnish and install a total quantity of four (4) double disc pumps. The pumps shall be Double Disc Pumps manufactured by Penn Valley Pump Company, Inc. Warrington, PA (215-343-8753) www.pennvalleypump.com or approved equal.

B. Pump Schedule

<u>Name</u>	<u>Quantity</u>	<u>Model No.</u>	<u>Capacity</u>	<u>Motor</u>
Residuals Pumps	2	6DDSX76CNU	0 to 500 gpm	10 Hp, 60Hz, 480 VAC
Recirculation pumps	2	3DDSX11	0 to 80 gpm	3 Hp, 60 Hz, 480 VAC

C. Pump Construction

1. Residuals Pump

- a. Each pump shall be a simplex heavy duty, free disc style positive displacement type, with Class 30 Cast Iron Housings. Duplex pumping arrangements are not acceptable. The pump shall consist of three (3) housings horizontally split to allow access to the

internal components. Incorporate the pump with a Maintain-in-Place hinged design that allows the pump to be serviced and discs replaced without removal of the pump or disturbing the suction and discharge piping. The discharge housing shall contain the mounting lugs and be bolted directly to the mounting frame. Incorporate an integral hinge arrangement for the discharge, intermediate and suction housings that allow the suction and intermediate housings to be lowered and removed. Connect the hinges to each other with a quick release ball detent pin allowing for easy pin removal.

- b. Provide pumps capable of 0.76 gallons per revolution when operating at 60ft head. The pumps shall be capable of operating dry for an indefinite period of time without damage. The pumps shall be capable of self-priming up to 14”Hg and 25”Hg when fully primed.
- c. Achieve pumping action by 2 free floating reciprocating discs attached to high tensile aluminum connecting rods driven by a rotating eccentric shaft. Mount each disc to the connecting rod by a stub shaft constructed of hardened high tensile 400 series stainless steel. The discs shall be of integral design and constructed of high tensile neoprene with multiple layers of fabric for longevity and strength. Pump designs that use a captive diaphragm with metal plate shall not be acceptable. Install universal and interchangeable suction and discharge discs with each other to increase the commonality of spare parts and eliminate confusion. The reciprocating action of the discs will perform the duty of valves. Pumps that require internal check valves for operation shall not be acceptable.
- d. Seal the pump fluid chamber with flexible trunnions made of fabric-reinforced neoprene and withstanding pressures from 0 to 110 PSI on an intermittent basis. The trunnion seal shall not be designed to provide any pumping action. Pump designs utilizing packing glands, mechanical seals or water seal systems will not be acceptable.
- e. Install a 2-piece design for the swan neck entry port to the suction housing to allow for mounting of the suction connection in 90 degree increments and easy access for clack replacement. Provide the upper swan neck with a 2-inch NPT connection to allow mounting of the suction pulsation dampener if required. Provide a full 6-inch diameter of the flange opening at the entry port with a minimum opening of 28.26 square inches to minimize debris buildup and blockages. Machine the seating surface for the clack valve on the mounting face of the swan neck. Integrally mount the

clack valve to the swan neck to facilitate access and replacement. Provide a neoprene constructed clack valve shall with multiple layers of fabric encapsulating a rigid core incorporating an integral O-ring seal for positive sealing. Designs that incorporate a separate clack valve plate and smaller diameter opening shall not be acceptable.

- f. Provide two (2) aluminum modular pedestals designed to provide accurate bearing alignment, superior bearing loading and ease of assembly for the bearing drive assembly. Provide a drive shaft capable of withstanding a dead head situation. Provide a shaft constructed of hardened 400 series high-tensile stainless steel and mounted on four (4) self-aligning, sealed bearings. Provide eccentric cams constructed of high tensile, cast bronze alloy and shall be pinned to the shaft by spiro drive pins to allow for the absorption of reciprocating loads generated by the pumping action. Pump drive assemblies that utilize keyways and setscrews will not be acceptable. All drive bearings must be completely sealed with no provisions for scheduled grease lubrication. No grease fittings supplied for the bearings.
- g. Drive the pump through a V-belt and drive assembly consisting of a 2 or 3 groove Type B arrangement. Size the pulley ratio's to provide the maximum pump speed listed in the pump schedule in this section and to provide the required torque generated between the pump and motor.
- h. Provide the pump with OSHA approved guards and covers. Manufacture the The V-belt drive cover and pump drive assembly cover from SS304 material. Mount each pump and V-Belt assembly on a common SS304 sub base. Raise base design cross-members on the suction and discharge end to allow for complete wash-out and draining without trapping liquid. Manufacture each sub base from SS304 square tubing. Ensure the base is sufficient gusseted, reinforced and braced to withstand all shock loads and resist all wearing and buckling during pump operation. Cap tubing ends with black plastic plugs for neat appearance.
- i. Provide pulsation dampeners on the suction and discharge lines. The dampeners shall be 6" ASA 150 lb flanged units and the main tube shall be SCH 40 carbon steel pipe with fully welded end caps. Mount the suction dampener directly to the suction swan neck through the NPT connection. The discharge dampener shall be a separate piece with 6" ASA 150# flanged connections. Pressure test the dampeners to 60 psi for leaks. Provide each dampener with a 1-inch half coupling located at the top. This connection shall be suitable for the vacuum and pressure switch assembly or

the ball valve/quick disconnect assembly should a switch not be specified. Supply each dampener with a 1 ½” NPT coupling and plug in the bottom to act as a drain/sample port. Bladder type and three-piece assemblies using connecting rods and gasket shall not be acceptable.

2. Recirculation Pumps

- a. Each pump shall be a simplex heavy duty, free disc style positive displacement type, with Class 30 Cast Iron Housings. Duplex pumping arrangements are not acceptable. The pump shall consist of three (3) housings horizontally split to allow access to the internal components. Incorporate the pump with a Maintain-in-Place hinged design that allows the pump to be serviced and discs replaced without removal of the pump or disturbing the suction and discharge piping. The discharge housing shall contain the mounting lugs and be bolted directly to the mounting frame. Incorporate an integral hinge arrangement for the discharge, intermediate and suction housings that allow the suction and intermediate housings to be lowered and removed. Connect the hinges to each other with a quick release ball detent pin allowing for easy pin removal.
- b. Provide pumps capable of 0.11 gallons per revolution when operating at 60ft head. The pumps shall be capable of operating dry for an indefinite period of time without damage. The pumps shall be capable of self-priming up to 14”Hg and 25”Hg when fully primed.
- c. Achieve pumping action by 2 free floating reciprocating discs attached to high tensile aluminum connecting rods driven by a rotating eccentric shaft. Mount each disc to the connecting rod by a stub shaft constructed of hardened high tensile 400 series stainless steel. The discs shall be of integral design and constructed of high tensile neoprene with multiple layers of fabric for longevity and strength. Pump designs that use a captive diaphragm with metal plate shall not be acceptable. Install universal and interchangeable suction and discharge discs with each other to increase the commonality of spare parts and eliminate confusion. The reciprocating action of the discs will perform the duty of valves. Pumps that require internal check valves for operation shall not be acceptable.
- d. Seal the pump fluid chamber with flexible trunnions made of fabric-reinforced neoprene and withstanding pressures from 0 to 110 PSI on an intermittent basis. The trunnion seal shall not be designed to provide any pumping action. Pump designs utilizing

packing glands, mechanical seals or water seal systems will not be acceptable.

- e. Install a 2-piece design for the swan neck entry port to the suction housing to allow for mounting of the suction connection in 90 degree increments and easy access for clack replacement. Provide the upper swan neck with a NPT connection to allow mounting of the suction pulsation dampener if required. Provide a full 6-inch diameter of the flange opening at the entry port with a minimum opening of 28.26 square inches to minimize debris buildup and blockages. Machine the seating surface for the clack valve on the mounting face of the swan neck. Integrally mount the clack valve to the swan neck to facilitate access and replacement. Provide a neoprene constructed clack valve shall with multiple layers of fabric encapsulating a rigid core incorporating an integral O-ring seal for positive sealing. Designs that incorporate a separate clack valve plate and smaller diameter opening shall not be acceptable.
- f. Provide two (2) aluminum modular pedestals designed to provide accurate bearing alignment, superior bearing loading and ease of assembly for the bearing drive assembly. Provide a drive shaft capable of withstanding a dead head situation. Provide a shaft constructed of hardened 400 series high-tensile stainless steel and mounted on four (4) self-aligning, sealed bearings. Provide eccentric cams constructed of high tensile, cast bronze alloy and shall be pinned to the shaft by spiro drive pins to allow for the absorption of reciprocating loads generated by the pumping action. Pump drive assemblies that utilize keyways and setscrews will not be acceptable. All drive bearings must be completely sealed with no provisions for scheduled grease lubrication. No grease fittings supplied for the bearings.
- g. Drive the pump through a V-belt and drive assembly consisting of a 2 or 3 groove Type B arrangement. Size the pulley ratio's to provide the maximum pump speed listed in the pump schedule in this section and to provide the required torque generated between the pump and motor.
- h. Provide the pump with OSHA approved guards and covers. Manufacture the The V-belt drive cover and pump drive assembly cover from SS304 material. Mount each pump and V-Belt assembly on a common SS304 sub base. Raise base design cross-members on the suction and discharge end to allow for complete wash-out and draining without trapping liquid. Manufacture each sub base from 2-1/2" SS304 square tubing. Ensure the base is sufficient gusseted, reinforced and braced to withstand all shock

loads and resist all wearing and buckling during pump operation. Cap tubing ends with black plastic plugs for neat appearance.

- i. Provide pulsation dampeners on the suction and discharge lines. The dampeners shall be 6" ASA 150 lb flanged units and the main tube shall be 8" diameter SCH 40 carbon steel pipe with fully welded end caps. Mount the suction dampener directly to the suction swan neck through the 3" NPT connection. The discharge dampener shall be a separate piece with 6" ASA 150# flanged connections. Pressure test the dampeners to 60 psi for leaks. Provide each dampener with a 1-inch half coupling located at the top. This connection shall be suitable for the vacuum and pressure switch assembly or the ball valve/quick disconnect assembly should a switch not be specified. Supply each dampener with a 1 1/2" NPT coupling and plug in the bottom to act as a drain/sample port. Bladder type and three-piece assemblies using connecting rods and gasket shall not be acceptable.

C. MOTOR

1. Adequately size the motor to withstand the loads during starting and pump operation. The power the horsepower and motor speeds shall conform to the specifications as outlined in the pump schedule in this section. Motor shall be severe duty, premium efficient, inverter ready per NEMA STD MG1 Part 31.4.4.2 with epoxy coated cast iron frame or equal.

D. SUCTION VACUUM PROTECTION

1. Provide a suction vacuum sensor and switch assembly to mount on the suction pulsation dampener. Provide a PVP420, Red Valve 42/742 or equal 1-inch NPT isolation pressure sensor with SS316 body and EPDM elastomeric sensing tube. Attach the gauge and switch to the sensor with SS316 fittings. Fit the vacuum assembly with 4" stainless steel 30"Hg – 30psi gauge and Ashcroft, Barksdale, or equal adjustable vacuum switch set at 10"Hg. Clean units in place by using the process pressure through a SS316 isolation valve mounted to the top of the sensor. Fit the opposite end of the valve with a universal, quick acting coupling, suitable for compressed air. This valve connection will be suitable to charge the dampener with compressed air.

E. DISCHARGE PRESSURE PROTECTION

1. Provide a discharge pressure sensor and switch assembly to mount on the discharge pulsation dampener from the pump manufacturer. Provide a PVP420, Red Valve 42/742 or equal 1-inch NPT isolation pressure sensor with SS316 body and EPDM elastomeric sensing tube. Attach the gauge and switch to the sensor with SS316 fittings. Fit the discharge assembly

with a 4" stainless steel 0 -100 psi pressure gauge and Ashcroft, Barksdale, or equal, adjustable switch preset at 30 psi. Clean the units in place by using the process pressure through a SS316 isolation valve mounted to the top of the sensor. Fit the opposite end of the valve with a universal, quick acting coupling, suitable for compressed air. This valve connection will be suitable to charge the dampener with compressed air.

D. Pump Accessories

1. Provide the following factory recommended spare parts for each set of pumps:
 - a. 2 Discs
 - b. 2 Trunnions
 - c. 1 Complete set of gaskets
 - d. 1 Clack Valve
2. Supply a universal, adjustable tool to aid in disc removal from the pump manufacturer.

E. FINISHES

1. Finish all cast iron and carbon steel components with manufacturer's standard industrial grade primer 2 – 3 mils DFT suitable for multiple top coat finishes and industrial enamel top-coat 2 – 3 mils DFT.
2. All stainless steel and aluminum surfaces will remain unpainted. Remove all weld splatter and all welds ground smooth for a neat appearance.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install per manufacturer's recommendations and as described by the Specifications and Drawings.
- B. Installation shall include furnishing and applying any initial supply of grease and oil, if required, recommended by the manufacturer.
- C. Installation shall include all electrical connections. Relays shall be provided as required for over temperature and high pressure shut-off the pumps.
- D. Support piping independent of equipment.

- E. Check and align equipment in accordance with manufacturer's recommendation.

3.02 START-UP SERVICE

- A. The equipment manufacturer shall furnish the services of a qualified factory trained field service engineer for a minimum of one 8-hour working day at the site to inspect the installation of each pump system. Contractor shall have manufacturer's representative provide 4 hours to instruct the owner's personnel on the operation and maintenance of the pumping units. After the pumps have been completely installed and wired, the contractor shall have the manufacturer do the following:
 - 1. Megger stator and power cables.
 - 2. Check seal lubrication.
 - 3. Check for proper rotation.
 - 4. Check power supply voltage.
 - 5. Measure motor operating load and no load current.
 - 6. Check level control operation and sequence.
- B. During this initial inspection, the manufacturer's service representative shall review recommended operation and maintenance procedures with the owner's personnel.
- C. The Contractor shall schedule and coordinate the manufacturer's start-up services accordingly with the sequence of construction of this project.

3.03 SPARE PARTS

- A. Provide the manufacturer's recommended spare parts for the first year of operation.

END OF SECTION

SECTION 11226

PRESSURE FILTERS

PART 1 GENERAL

1.01 DESCRIPTION

- A. This section of the specifications provides for an automatic, pressure type filtration system complete and operable as indicated on the drawings and as specified herein.
- B. To assure compatibility between pieces of equipment the following items included in this section are to be furnished by the water treatment equipment manufacturer:
 - 1. Treatment Vessels
 - 2. Inlet Distributors/Waste Collectors
 - 3. Sandvalve Underdrain Distributors
 - 4. Support Gravel
 - 5. Filtration Media
 - 6. Automatic Control and Isolating Valves
 - 7. Filter Face and Filter Interconnecting Piping
 - 8. Control Panel
- C. All interconnecting wiring and conduit, motor starters, and appurtenant electrical work associated with the filtration system shall be furnished and installed by the general contractor in accordance with electrical specifications.

1.02 REQUIREMENTS

- A. It is the intention of these specifications that the pressure filter specified in this section shall be furnished as part of a coordinated system supplied by a single manufacturer so that undivided responsibility for a complete and operable system is assured. The pressure filter manufacturer shall be the coordinating supplier of the pressure filter system. The pressure filter system shall include the pressure filters and all other equipment and accessories specified herein.
- B. Equipment Supplier:
 - 1. The pressure filters and equipment shall be by Hungerford & Terry, Inc., Clayton, NJ, or approved equal.
 - 2. Approved alternates shall only be considered before award of the project.
 - 3. Other Suppliers may apply for pre-qualification during the bidding period by providing the Engineer the following information fifteen (15) days prior

to the opening of bids:

- a. Description of the equipment proposed
 - b. Detailed drawings, specifications, and product literature with adequate detail showing the proposed equipment layout and construction materials as required to determine that the proposed alternate equipment will meet the requirements set forth in the specifications.
 - c. List of ten (10) operational installations with contact names, addresses, and phone numbers of similar installations. "Similar Installations" are defined as municipal pressure filtration systems for drinking water applications that have a total capacity equal to or greater than that specified herein.
 - d. Sufficient information to show compliance with these specifications.
 - e. Evidence of technical capability to design and check out the complete alternate system; including modifications which will be required in structures, foundations, and existing and peripheral equipment provided by others.
 - f. Evidence of adequate financial resources to complete the project, assume liability for the equipment warranty, and furnish critical replacement parts over the lifetime of the alternate equipment.
 - g. A complete listing of changes which will be required in the contract Plans and Specifications to accommodate the alternate equipment.
 - h. Installation, operation and maintenance manuals specific to the proposed equipment
4. Any exceptions to these specifications shall be so noted in the pre-qualification submittal and reasons shall be given in writing for each exception.
 5. Alternate system manufacturers shall guarantee, in writing, signed by an officer of the company that the equipment offered will provide comparable or superior features, performance, quality, and materials of construction as defined in the specifications.
 6. The prior approval of alternate equipment shall not constitute final approval of the specific equipment, but rather constitutes acceptance of the respective equipment manufacturers to provide price quotations based on equipment meeting the Specifications. Shop submittals will be required as specified herein. Approval of

alternate equipment does not guarantee approval of submittals.

7. Contractor shall assume overall undivided responsibility for the functioning of the specified equipment or any alternate equipment. The cost of any changes incidental to the installation of the alternate equipment such as electrical wiring, relocation of piping, engineering design or supervision, as-built drawings etc., shall be borne by the Contractor with no additional cost to the Owner.
8. Engineer shall, five (5) days prior to opening bids, issue an addenda listing Suppliers that are acceptable to the Engineer.

1.03 SUBMITTALS

- A. The filtration equipment supplier shall submit to the Engineer four (4) complete sets of shop drawings, details, data sheets, and other descriptive drawings and material as may be required to fully describe the equipment proposed and to verify compliance with the contract documents.
- B. All submittals shall be complete, neat, and orderly and follow the requirements of Section 01340. The submittals shall include the following, as applicable:
 1. Custom, CAD generated shop drawings pertinent to this specific application showing interconnections of the components in the system, including scaled double line piping drawings (schematics will not be acceptable), control logic schematic/wiring diagrams, control panel drawings to include front panel view, internal wiring detail, and panel internal arrangements, control panel equipment charts, equipment arrangements, installation and erection details, anchor bolts, equipment pads, etc.
 2. Detailed descriptions of each piece of equipment specified.
 3. Description of the operation and control of the equipment along with a annotated copy of the control logic program.
 4. Four (4) copies of operation and maintenance requirements for the system.

1.04 PERFORMANCE AND DESIGN REQUIREMENTS:

- A. The pressure filter system shall be specifically designed to provide filtration and treatment for iron and manganese removal from groundwater. The filter media shall consist of GreensandPlus and anthracite. A sodium hypochlorite chemical feed system (specified elsewhere) shall serve to catalytically regenerate the GreensandPlus.

B. Design requirements are as follows:

1. The pressure filter equipment shall be designed based on the following requirements:

- a. System design flow rate 2100 GPM
- b. Unit design flow rate 2100 GPM
- c. Filter loading rate at design flow 7.0 GPM/FT²
- d. Normal maximum operating pressure 100 PSI
- e. Influent water quality after pre-treatment pH adjustment:

Iron	.484 mg/L, avg
Manganese	.106 mg/L, avg
pH	7.3

2. The pressure filter backwash water source shall be provided from storage. Temperature of the backwash water will be 55 degrees F.

- a. Normal filter backwash rate..... 15.9 GPM/FT² @ 55 deg. F.

C. Plant effluent guarantee:

The pressure filter manufacturer shall review the filter influent raw water quality and the specific requirements of these specifications, and shall guarantee in writing that the equipment supplied hereunder will consistently produce a plant effluent having iron and manganese concentrations as noted below:

Iron (Fe)	Maximum concentration 0.30 mg/L
Manganese (Mn)	Maximum concentration 0.05 mg/L

PART 2 PRODUCTS

2.01 FILTER TANKS

- A. System will consist of two (2) horizontal pressure filters, 12'0" foot O.D. by 25'0" straight shell. Each horizontal pressure filter shall be of the "two cell" design with a common underdrain.
- B. The filter tanks shall be of welded steel construction using SA-516 Grade 70 steel, and shall be tested to withstand a hydrostatic pressure 30% in excess of the designed working pressure of 100 psi. The tanks shall be designed in accordance with the requirements of the latest ASME code section VIII construction and include the code stamp.

- C. The filter tank shall be of the “two cell” design. The lower portion of each filter tank shall require a concrete sub-fill. A “flat” bottom or “curved” bottom under drain plate is not acceptable.
- D. Tanks are to include the following features:
 - 1. Two (2) 24 inch diameter manways with lifting davits and spare gaskets. Each cellular compartment shall have one manway.
 - 2. Flanged nozzle type connections as shown on the drawings.
 - 3. Two structural steel saddles to support the total weight of the filter.
 - 4. Sufficient number of lifting lugs designed to support the entire weight of the filter assembly.
- E. Tank interiors are to be white metal sandblasted per SSPC-SP-10 and lined with a Tnemec Series N140F (low VOC) Pota-Pox Plus polyamidoamine epoxy potable water coating system consisting of the following:
 - 1. One (1) coat (5.0 - 8.0 mils DFT) of Tnemec #N140 - 1255 Pota-Pox Plus primer (beige).
 - 2. One (1) coat (5.0 - 8.0 mils DFT) of Tnemec #N140-15BL Pota-Pox Plus finish (tank white).
- F. Tank exteriors are to be commercial sandblasted per SSPC-SP6, and painted with one (1) shop coat (3.0 – 5.0 mils DFT) of Tnemec Hi-Build Epoxoline II N69F primer.
- G. Finish painting of the tank exteriors shall be furnished and field applied by others in accordance with the painting section of the specifications.
- H. The Contractor shall also be responsible for all touch-up painting required upon completion of the work. All work shall be performed in accordance with paint manufacturer’s specification.

2.02 FILTER INLET DISTRIBUTORS/WASTE COLLECTORS

- A. Each filter cell shall be equipped with an inlet distributor/backwash collector designed with Sch.10 #316 stainless steel manifolds with orifices drilled on top of the manifold at required intervals for proper distribution.

The inlet distributors/backwash collector shall be completely installed by the Filter Manufacturer prior to shipment. Baffle plate distributors are not acceptable.

2.03 UNDERDRAIN SYSTEM

- A. Each filter tank shall be equipped with a header-lateral underdrain system that is engineered to provide uniform collection of filtered water and uniform distribution of backwash water. The distributor shall consist of a schedule 80 PVC manifold and laterals. Each lateral is to include 5 inch square stainless steel, monel, and delrin sand valve assemblies as manufactured by Hungerford and Terry, Inc., Clayton, New Jersey, or approved equal. Sandvalves are to be installed on 15 inch maximum centers. A "gravel-less" type underdrain system will not be acceptable.
- B. The sandvalve type underdrain will require a concrete fill of the lower portion of the filter vessel up to the bottom of the sandvalves. All concrete is to be furnished and installed by the contractor.
- C. The underdrain systems shall be installed by the filter manufacturer prior to shipment.

2.04 GRAVEL SUPPORTING BED

- A. A gravel support bed shall be incorporated in the bottom of each vessel, consisting of five (5) layers of graded gravel, with the largest size gravel loaded into the filter first and the succeeding smaller sizes placed on top. The gravel graduations shall be as follows:

1/8" x 1/16"	4.0 inches
1/4" x 1/8"	4.0 inches
1/2" x 1/4"	2.0 inches
3/4" x 1/2"	2.0 inches
1.5" x 3/4"	4.0 inches

- B. The gravel shall be "Cape May" quality, washed and screened, and shipped in clearly marked one hundred (100#) pound bags. The gravel must meet the requirements of the American Water Works Association (AWWA) Specification number B-100-89.
- C. All gravel is to be field installed by the general contractor.

2.05 FILTRATION MEDIA

- A. Each filter is to be provided with a 24 inch deep bed of GreensandPlus. The GreensandPlus is to meet the following criteria:

1. Specific gravity: approx. 2.4
2. Effective size: 0.30 - 0.35 mm
3. Uniformity coefficient: less than 1.6
4. Screen grading: 18 x 60 mesh

B. In addition to the GreensandPlus filter media, the equipment supplier shall provide a 12 inch depth of specially graded anthracite. The anthracite is to meet the following criteria:

1. Specific gravity: approx. 1.6
2. Effective size: 0.6 - 0.8 mm
3. Uniformity coefficient: less than 1.6

C. The total GreensandPlus and anthracite bed depth shall total 36 inches.

D. The anthracite and gravel shall be shipped in one (1) cubic foot bags on pallets, and the GreensandPlus shall be shipped in ½ cubic foot bags on pallets.

E. All media shall be accepted under ANSI/NSF Standard 61.

F. GreensandPlus shall be loaded into the filters and conditioned in accordance with the manufacturer's recommendations. The conditioning solution shall be supplied by the contractor

G. All filter media is to be field installed by the contractor.

2.06 FILTER EXTERIOR VALVING

A. Each filter shall be furnished with an automatic and manual valve nest exterior consisting of the following:

1. Automatic valving:

Bray Series 30 butterfly control valves with wafer style cast iron bodies, nylon coated discs, metal reinforced EPDM seats. Provide Bray Series 70 electric motor operators for operation on 120 VAC, with isolated contact position limit switches, and anti-condensation heaters.

Valves are to be furnished for the following filter sequences:

- a. Inlet (8 inch) 2 ea.
- b. Outlet (10 inch)
- c. Backwash inlet (10 inch)

- d. Backwash outlet (10 inch) 2ea.
- e. Rinse outlet (10 inch)

2. Manual isolating valves:

Bray Series 30 butterfly valves with wafer style cast iron bodies, nylon coated discs, field replaceable EPDM seats, and manual gear operators.

Valves are to be furnished for the following:

- a. Filter inlet isolating (10 inch)
- b. Filter outlet isolating (10 inch)

3. Manual ball valves:

Flow-Tek stainless steel ball valves with manual lever operators.

Valves are to be furnished for the following:

- a. Drain (2 inch)
- b. Backwash tell-tale (1/2 inch)

4. Automatic air release valves:

Apco Model No. 200A automatic air release valves, 1" with threaded cast iron bodies, stainless steel floats, and an isolating ball valve.

2.07 FILTER SYSTEM & FILTER INTERCONNECTING PIPING

A. Water service piping:

- 1. All filter face and interconnecting piping is to consist of class 53 ductile iron pipe with 150# threaded ductile iron flanges, and flanged class 250 ductile iron fittings.
- 2. All piping is to include an internal cement lining and bituminous seal coat in accordance with the proper AWWA specifications.
- 3. Filter system piping shall be commercial sandblasted (SSPC-SP6) and lined with one (1) prime coat of Tnemec 69F.
 - a. All pipe supports shall be provided for by the contractor.

- b. All system face and interconnecting piping shall be furnished with the required bolts, studs, nuts, and gaskets as follows:

Bolts:	ASTM A307 grade B plated carbon steel
Studs:	ASTM A307 grade B plated carbon steel
Nuts:	ASTM A563 or A194 2H plated steel heavy hex
Gaskets:	Neoprene (shore A) 70 or equal, 1/8" thick

2.08 START-UP CHEMICALS

- A. For every 100 cubic feet of GreensandPlus, 20 gallons of 15% bleach, or 50 gallons of 6% bleach is required for conditioning of the media and disinfecting of the tanks.
 - 1. Disinfection shall be performed by the contractor.
 - 2. Chemical shall be supplied by the contractor.

2.09 SYSTEM ACCESSORIES

- A. Filter Pressure Equipment:
 - 1. One (1) Ashcroft Model D-400 snap acting differential pressure switch with a NEMA 4 enclosure complete with three (3) manually operated ball valves. The differential pressure switch shall detect the d/p across the filter common inlet and common outlet headers.
 - 2. Two (2) Ashcroft Model 1279AS pressure gauges with 4.5 inch diameter dials, and stainless steel bourdon tubes shall be furnished for each filter unit inlet and outlet.
 - 3. Each pressure switch and gauge shall be furnished with polypropylene supply tubing, manual isolating valves, and sampling valves.
- B. Filter Flow Equipment:
 - 1. Each common filter inlet header & common backwash outlet header shall be equipped with a Toshiba GF630/LF620 magnetic flowmeter , complete with 150 lb. flanged carbon steel process connections, polyurethane liner, #316 stainless steel electrodes, integral mounted aluminum NEMA 4X housing with local display and 4-20 mA output, and grounding rings.

2.10 FILTER SYSTEM CONTROL PANEL

- A. Furnish one (1) NEMA-12 wall mounted type control panel of steel construction complete with a Allen Bradley CompactLogix L3 Ethernet programmable controller or equal, Automatic Direct 10" diagonal color touchscreen Operator Interface Terminal, Ntron #104TX Ethernet Managed Switch, Phoenix Contact terminal blocks, internal type THHN wire, Phoenix Contact AC surge suppressor, 24VDC power supply, C3 Controls door mounted disconnect switch, Allen Bradley #700-HK series interposing relays or equal, Panduit type G gray wire duct, Phoenix Contact heat-shrink white wire sleeves, Sixnet Ethernet surge suppressor, GFCI duplex outlet, and UL-508 label. Electrical power supply to panel shall be 20 Amps at 120 Volts, single phase.

The Filter Control Panel shall provide isolated output contacts for the following signals:

1. Filter 1 Operating
2. Filter 2 Operating
3. Filter 1 In Backwash
4. Filter 2 In Backwash
5. Filter Control Panel Common Alarm

PART 3 EXECUTION

3.01 INSTALLATION

- A. All water filtration equipment shall be installed as shown on the drawings and in accordance with manufacturer's instructions and recommendations and the approved Shop Drawings.

3.02 TESTING

- A. Upon completion of the installation, the GreensandPlus units shall be regenerated prior to acceptance.
- B. Greensand filters and piping connections shall be pressure tested by the contractor.
- C. Prior to placing into service each filter shall be disinfected. Disinfection shall be performed by the contractor

3.03 MANUFACTURER'S SERVICES

- A. The supervisory service of a factory trained service technician, who is specially

trained in the type of equipment herein specified, shall be provided for a period of two (2) 8 hour man days during construction. The service technician shall assist the Contractor or Subcontractor with technical advice on the installation of the major components of the equipment.

- B. The supervisory service of a factory trained service technician shall be provided for a period of four (4) 8 hour man days during media loading. The service technician shall supervise the Contractor or Subcontractor with technical advice on the installation of the filter media to include:
1. Placement of gravel support material
 2. Supervision of GreensandPlus media loading
 3. Backwashing and undercutting of the GreensandPlus
 4. Supervision of anthracite media loading
 5. Conditioning of the filter media
- C. Upon completion of the installation, the services of a factory trained service technician shall be provided for a period of four (4) 8 hour days to commission the filtration system, check the completed installation, make any required adjustments, and place the system in satisfactory operation.
- D. In addition to the above, the Manufacturer shall provide the services of the above service technician for one (1) day for instructing operating personnel.

END OF SECTION

SECTION 11240

SUBMERSIBLE MIXERS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. The Contractor shall furnish and install submersible mixers, controls, appurtenances, and accessories indicated on the Drawings and specified herein. Spare parts shall be included.

1.02 SUBMITTALS

- A. Submit under the provisions of Section 01340.
- B. Shop Drawings: Indicate in large scale detail, fabricated equipment showing construction methods and locations in plan and cross section, mounting requirements and clearances, and utility requirements as to types, sizes and locations. For control system, indicate service connections, characteristics and wiring diagrams.
- C. Product Data: Provide equipment dimensions and construction, equipment capacities, characteristics and limitations, materials, finishes, utility requirements and locations.
- D. Manufacturer's Installation Instructions: Indicate installation requirements and special procedures.

1.03 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01700.
- B. Operation Data: Provide operating data for specified equipment.
- C. Maintenance Data: Provide lubrication and periodic maintenance requirements and schedules.

1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with Section 01400.
- B. All mixers will be tested and verified for electrical and mechanical integrity.
- C. A statement by the mixer manufacturer attesting to the factory test results shall be furnished to the Owner and Engineer upon request.

- 1.05 DELIVERY, STORAGE AND HANDLING
- A. Deliver, store, protect and handle equipment according to manufacturer's instructions and provisions of Section 01600.
- 1.06 SCHEDULING AND COORDINATION
- A. Schedule Work under the provisions of Section 01310.
- B. Coordinate the delivery and installation of the Work of this Section with the Work of other sections.
- 1.07 WARRANTY
- A. The manufacturer shall provide a warranty against any defect or malfunction due to the workmanship in the equipment and accessories for a period of one year from the date the system is put into service.
- B. A written manufacturer's warranty shall be supplied.
- 1.08 PROJECT RECORD DOCUMENTS
- A. Submit under provisions of Section 01700.
- B. Record actual locations of pipes, utilities, equipment and accessories.
- 1.09 MANUFACTURER'S REPRESENTATIVE
- A. Furnish the services of a qualified equipment manufacturer's representative for a minimum of one 8 hour day visit after equipment installation for testing, instruction, and correction of deficiencies. One half of this time shall be reserved for Owner instruction. Should correction of deficiencies require additional days, provide manufacturer's representative's time, at no additional cost to Owner until system performs as specified.
- B. The Contractor shall schedule and coordinate the manufacturer representative's services according with the sequences of construction for this project.
- PART 2 PRODUCTS
- 2.01 GENERAL REQUIREMENTS
- A. Furnish and install 2 industrial submersible mixer(s). Each mixer shall be equipped with a 2.5 HP, submersible electric motor connected for operation on 460 Volts, 3 Phase, 60 Hertz, 8 wire service, with 30 Ft. of 14 AWG Subcab cable. All cables shall be oil resistant chlorinated polyethylene rubber jacketed. Each unit shall be fitted with 40 ft. minimum of lifting cable of adequate strength to permit raising

and lowering the mixer. Mixers specified herein shall have propeller code 083706SJ. Mixers specified herein shall be as follows:

Mixer Location	Number of Units	Model Number	HP	Accessories
Solids Holding Tank	2	4630	2.5	Mount Assembly

2.02 MANUFACTURER REQUIREMENTS

- A. The mixing equipment specified herein shall be the design and fabrication of a single manufacturer which shall have sole source responsibility for said equipment. The mixers shall be as manufactured by ITT Flygt, or approved equal.

2.03 MIXER DESIGN

- A. The mixer(s) shall be capable of handling industrial items such as solids, process liquids and raw, screened sewage. The mixer(s) shall be able to be raised and lowered and shall be easily removed for inspection or service without the need for personnel to enter the mixing vessel. A sliding guide bracket shall be an integral part of the mixer unit. The entire weight of the mixer unit shall be guided by a single bracket which must be able to handle all thrust created by the mixer. The standard mixer, with its appurtenances and cable, shall be capable of continuous submergence under water, without loss of watertight integrity, to a depth of 130 ft.

2.04 MIXER CONSTRUCTION

- A. Each mixer shall be of the integral design, close coupled, submersible type. All components of the mixer, including motor shall be capable of continuous underwater operation.
- B. Major mixer components shall be of 304 Stainless Steel construction. The oil housing cover plate shall be of corrosion resistant composite. All exposed fasteners shall be of stainless steel. In order to insure that the low velocity area around the motor remains impervious to low PH solids and or liquid attack, the motor housing exterior shall be made of 316 Stainless Steel. All metal surfaces coming into contact with the mixed media, other than stainless steel, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with an epoxy finish coat on the exterior of the mixer.

2.05 MOTOR

- A. The multi-pole motor shall be directly connected to the propeller (gearbox designs are not acceptable) to produce a propeller speed of 855 RPM. The mixer motor shall be

squirrel cage, induction, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31. The motor shall be designed for continuous duty, capable of no less than 30 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum.

Thermal sensors shall be used to monitor stator temperatures. The stator shall be equipped with three (3) thermal switches embedded in the end coils of the stator winding and set for 284°F (140°C). These shall be used in conjunction with, and supplemental to, external motor overload protection, and wired to the control panel.

2.06 ELASTOMERS

- A. All mating surfaces where watertight sealing is required shall be machined and fitted with a double set of Nitrile rubber, Viton or Terban O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This will result in controlled compression of the O-rings without requiring a specific torque limit. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease or other devices shall be used.

2.07 PROPELLER

- A. The propellers shall be of 316 stainless steel dynamically balanced, non-clogging backward curved design. Each blade shall be laser cut and welded to the hub to ensure that the propeller is properly balanced. The propeller shall be capable of handling solids, fibrous materials, heavy material and other matter found in typical industrial applications. The propellers shall have three (3) vanes 14-7/16 inches in diameter with a blade angle of 6 degrees.

2.08 JET RING ASSEMBLY

- A. The mixer assembly shall incorporate a jet ring a full 360 degrees around the propeller.

2.09 CABLE ENTRY

- A. The cable entry housing shall be an integral part of the back plate. The cable entry shall have a double set of elastomer grommets in order to ensure a redundant system in the event of a cable entry failure. Single sealing systems will not be deemed acceptable. The cable entry shall be comprised of two cylindrical elastomer grommets, each flanked by washers and a ferrule designed with close tolerance fit against the cable outside diameter and the entry inside diameter. This will provide a

leak proof, torque-free seal at the cable entrance without the need for specific torque requirements. The assembly shall bear against a shoulder in the stator casing opening and be compressed by a gland nut threaded into it. Interaction between the gland nut and the ferrule should move the grommet along the cable axially instead of with a rotary motion. The junction chamber and motor compartment shall be separated by a terminal board which shall protect the motor interior from foreign material gaining access into the mixer top. Connection shall be made between the threaded compressed type binder posts thus securely affixing the cable wires to the terminal board. The use of the terminal compressed type post and a terminal board O-ring shall render the motor compartment leak proof from any liquid which may enter the terminal compartment. **Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.**

2.10 BEARINGS

- A. All bearings shall have a minimum B-10 or L-10aa rated life of 100,000 hours and shall have inner and outer races of metal construction. Bearings with races made of nonmetallic construction will not be deemed acceptable or meeting the load handling and environmental requirements of this application. The outboard propeller bearing shall be an angular contact bearing. The motor shaft end shall be supported by two bearings. A roller and an angular contact ball bearing shall take up the axial and radial loads while an angular contact ball bearing shall take up the axial loads. The bearings shall be pre-loaded by a bearing loading nut located on the motor end of the shaft in order to reduce shaft deflection and increase bearing life and seal life. Mixers without pre-loaded bearings will not be considered acceptable or equal.

2.11 OIL HOUSING

- A. The oil housing shall contain two compartments consisting of an inner and an outer section with four ports to connect and facilitate oil flow. In the event that the mixed media bypasses the other seal, this design will allow the outer compartment to collect the heavier (denser) fluids by means of a simple gravity process. Mixers which require propeller removal for oil change shall not be acceptable. Separate fill and drain plugs shall be provided to facilitate oil replacement.

2.12 MECHANICAL SEALS

- A. The standard inner mechanical seal is corrosion resistant Tungsten Carbide/Aluminum Oxide. The outer seal faces are Tungsten Carbide/Tungsten Carbide. One face of the inner seal ring pair shall have spiral grooves laser etched in it, to provide a pumping action to move leakage from the stator housing back into the oil chamber. In order to avoid seal failure due to sticking, clogging, and misalignment from elements contained in the mixed media, only the seal faces of

the outer seal assembly and its retaining clips shall be exposed to the mixed media. All other components shall be contained in the oil housing.

2.13 SEAL SHIELD

- A. The mixer shall be equipped with a seal shield that prevents fibrous material from winding up around the shaft and outer seal. The shield shall be welded to the propeller hub and extend towards the motor. The shield shall rotate with the propeller and there shall be a radial micro-gap between the shield and oil-housing.

2.14 MIXER TEST

- A. The mixer manufacturer shall perform the following inspections and tests on each mixer before shipment from the factory:
 - 1. Propeller, motor rating, and electrical connections shall first be checked for compliance to the customer's purchase order.
 - 2. A dielectric test shall be carried out in accordance to IEC 60034-1 (two times rated voltage plus 1000V). This test shall be done after assembly but before any performance tests. No records shall normally be provided.
 - 3. Prior to shipment, the mixer shall be run dry to establish correct rotation and mechanical integrity.
- B. A written report stating the foregoing steps have been done shall be supplied with each mixer at the time of shipment upon request.

2.15 MIXER MOUNTING AND RETRIEVAL SYSTEM

- A. Stainless steel mixer wall mount assembly shall be supplied to mount the mixer(s) during operation and to guide the unit(s) during installation and removal from service. The assembly shall consist of upper, lower and, if required, intermediate mounting brackets made of 316 stainless steel.
- B. Each mixer mount assembly shall include a 40 ft. field adjustable length of 316 stainless steel mixer support cable. A 2" x 2" x 3/16-inch wall thickness mast shall securely interface with the mixer manufacturer's upper, lower and intermediate brackets and integrate in such a way as to securely support the mixer during operation
- C. Overall installed length shall be field adjustable. All support bracket assemblies shall be supplied by the mixer manufacturer only, to ensure the integrity of the system under operational loads.

- D. For mast heights up to 20 ft., the assembly shall also be provided with three cable holders to secure the mixer electric power cable. For mast heights greater than 20 ft. additional cable holders must be purchased from the mixer manufacturer. These cable holders shall be installed on the power cable every 5 ft., to provide lateral support of the power cable. In addition, a cable support grip shall be provided to hold the weight of the power cable. These grips and support are used to prevent the electric cable from becoming entangled in the mixer propeller during operation
- E. The mixer shall have the capability of redirecting the center line of its jet +/-10 or +/- 20 degrees in a vertical plane and 120 degrees in a horizontal plane and can be repositioned for operation at any elevation along the complete mast assembly. The mast shall be constructed with a positioning locking plate which will work in conjunction with a bolts through the upper guide holder to positively lock the mast in place at various operating angles. All the above shall be capable of being accomplished without draining the tank.
- F. Mixer mounting system shall be the ITT Flygt 2" System 4 Mixer Mount Assembly, or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions, drawings and/or approved shop drawings.
- B. Installation shall include furnishing and applying any initial supply of grease and oil, if required, recommended by the manufacturer.
- C. Installation shall include all electrical connections including wiring for short circuit protection and thermal overload sensor as recommended by the manufacturer. Relays shall be provided as required.
- D. Check and align equipment in accordance with manufacturer's recommendation.

3.02 INITIAL OPERATION

- A. After the installation is complete, a qualified factory representative shall place the mixers in operation, conduct a complete function check, and make all necessary adjustments for regular service.

3.03 SPARE PARTS

- A. Provide the manufacturer's recommended spare parts for the first year of operation.

END OF SECTION

SECTION 11310

METERING EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish and install metering equipment and appurtenances as indicated on the Drawings and as specified herein.

1.02 SUBMITTALS

- A. Submit shop drawings, manufacturer's product data and installation instructions in accordance with Section 01340.
- B. Submit certified accuracy test record for flow meter.

1.03 QUALITY ASSURANCE

- A. Volumetric testing of all meters must be performed prior to shipment. The complete meter assembly must be accuracy testing in the same pipe size and same type tube that the meter will be mounted in. The test shall be near minimum, intermediate, and maximum manufacturers specified flow ranges of the meter. The test facility must be certified annually to an accuracy of $\pm 0.2\%$ and be traceable to the National Institute of Standards and Technology.

1.04 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Sections 01340.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle equipment according to the provisions of Section 01600.

1.06 WARRANTY

- A. Provide a 2 year warranty which begins at the time the system is placed in service.

1.07 MANUFACTURER'S REPRESENTATIVE

- A. Furnish the services of a qualified equipment manufacturer's representative.

PART 2 PRODUCTS

2.01 PROCESS FLOW METER

- A. Provide electromagnetic flowmeters that consist of two units, a detector and a converter. The detector shall measure flows and in which low-level signals proportional to flow rates are obtained. The converter shall supply excitation current to the detector, and amplify the signals from the detector and then process and converts the signals into the 4-20m Adc current signal or communications signal.
- B. The meters shall be 1-1/4" for recycle and 16" for influent and distribution, capable of measuring 3.5 to 5000 gpm (anticipated average flow range is 1111 gpm for meter) with registration accuracy of 100% ± 1.5% of actual throughput, and include a stainless steel strainer which shall be integral and cast as part of the meter's maincase.
- C. Ends shall be flanged: Flanges shall be ASME B 16.5 class 150.
- D. The tube shall have straightening vanes and are protected internally with 12-25 mils of NSF approved fusion epoxy resin.
- E. Register shall be fully electronically sealed with an electronic pickup containing no mechanical gearing.
- F. Installation - The meter can be installed in any of the following positions: vertically, horizontally or inclined on suction or discharge lines. The meter must have a full flow of liquid for proper accuracy
- G. O-Ring Seals - are used at the meter head and all points where seals are required, making the meter mechanism completely immune to any of the corrosive effects of atmospheric moisture or the liquids measured by the meter assembly.
- H. NSF Approved Materials -

Maincase – Carbon Steel
Flange – Carbon Steel
Measuring Tube – 304 stainless steel
- I. Meters shall be 16" GF632 Electromagnetic Flowmeter as manufactured by Toshiba or approved equal.

2.02 ANALYZERS

- A. The pH / Chlorine Analyzer
 - 1. pH/Chlorine analyzer shall be HACH – CLF10 complete system with dual input SC200 controller or equal.

2. The analyzer shall have a chlorine sensor and combination pH electrode for precise monitoring, and independent process temperature readings. The complete system shall have a digital controller that mounts remotely and includes a 3' cable. The monitoring system shall have two, 4-20mA analogue outputs. The analyzer shall have a free chlorine response time of 140 seconds or less for 90% change at a stable temperature and pH. Installation shall adhere to manufactures recommendations.

B. Fluoride Analyzer

1. The Acid Analyzer shall be CA610 Fluoride Analyzer as manufactured by HACH Company, or approved equal.
2. The fluoride analyzer shall employ an ion-selective electrode method of measurement using TISAB reagent and capable of measuring fluoride every 4.2 minutes. The analyzer shall have three digit LCD readout in the range of 0.1 to 10 mg/L and shall display results. It shall be house in an IP62-rated, ABS plastic enclosure designed for wall mounting. The analyzer shall be microprocessor-controlled and provide a 4-20mA recorder output with two alarms.

C. Turbidity Analyzers

1. The Turbidity Analyzers shall be HACH 1720E Low-Range Turbidimeters as manufactured by HACH Company, or approved equal.
2. The meters shall consist of a turbidity sensor and digital controller that continually samples flows through a sensor, 6 ft. digital cable, and mounting kit. The sensor shall contain a de-bubbler that vents entrained air.

D. Spare Parts

1. One additional sensor for each parameter measured by the analyzers shall be supplied as spare parts.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install all components of metering systems in accordance with Drawings, manufacturer's instructions and Section 01600.
- B. Furnish all accessories and components as required to provide a complete working system in accordance with manufacturer's recommendations.
- C. After installation is complete, a qualified factory representative shall place each metering system in operation, conduct a complete function check and make all necessary adjustments for regular service in accordance with Sections.
- D. Provide electrical and communications systems as required by Electrical specifications.

3.02 TESTING AND DEMONSTRATION

- A. Start-up, test and demonstrate flow meter systems in accordance with Sections 01600 and 11000.
- B. Provide 4 hours of instruction to Owner in accordance with Sections 01600 and 11000.

END OF SECTION

SECTION 11332

HYDRATED LIME EQUIPMENT

PART 1 GENERAL

1.01 SCOPE

- A. The contractor shall furnish all labor, materials, equipment and incidentals required and deliver, and place into satisfactory operation, one complete Hydrated Lime System as specified herein and as shown on the drawings.

1.02 QUALITY ASSURANCE

- A. The equipment shall be the product of a systems supplier who is regularly engaged in chemical feed system design and supply having experience rehabilitating chemical silo storage and delivery systems.
- B. The major components of the Hydrated Lime System shall be furnished by a single supplier to facilitate maintenance and stocking of repair parts as well as providing a single source of responsibility over the system.
- C. The specifications and drawings covered by this section are based on equipment designed and manufactured by Velocity Dynamics or approved equal.
- D. Any and all exceptions to the below specification shall be mentioned in detail on the supplier's proposal.
- E. The system supplier shall prepare shop drawings that verify that each system component is compatible with other components of the system, and that piping materials and sizes are appropriate, and that devices necessary for a properly functioning system have been provided.
- F. Owner may require verification of qualifications by requesting the following information:
 - 1. Financial Capability.
 - 2. Names of manufacturers whose products are normally supplied by the Hydrated Lime feed supplier and the type of business relationship with each.

3. That the manufacturer maintains a design office with a qualified technical staff.
4. That the manufacturer maintains fabrication facilities.
5. That the manufacturer has and will maintain competent service personnel to service equipment furnished.
6. That manufacturer has successfully provided similar work for at least five (5) years.

1.03 SUBMITTALS

- A. Submit the information as specified in section 01340.
- B. Shop Drawings
- C. Operation & Maintenance Manual

PART 2 PRODUCTS

2.01 Hydrated Lime Feed Equipment

- A. Manufacturers
 1. Velocity Dynamics or approved equal.
- B. Storage Silo Rehab
 1. The existing storage silo shall be rehabilitated to include the new feed train as described below.
- C. Dehumidifier System
 1. 175 CFM 40-45 gr/lb. less than ambient resulting in dew point less than shell temperature.
 2. Desiccant Dehumidifier with Reactivation heater and fan
 3. NEMA 4 enclosure with indicating package and rotation fault circuits
 4. Insulated air supply plenum
 5. Air filter: 30%

6. Internal bypass with manual damper
 7. 208-240/1/60 with 4.53 FL KW
- D. Feed Train #1 : Location : Existing Silo
1. Electric Actuated Diverter Valve
 - a. Y Diverter Type
 - b. Gravity Vee Diverter Valve. Valve bodies to be 6061-T6 aluminum with 304 stainless steel blades. Material contact is 304 stainless steel and polymer. Round inlet and outlet transitions to be constructed of 304 stainless steel. Valve body to be modified to accept proximity switches (plugged if indication switches are not utilized).
 - c. To be rated for 180°F(82°C) maximum continuous service. PET side seals and upper and lower bonnet seals are live loaded and silicone rubber backed. Valve also includes cam-adjustable slide rollers and PET roller spacers. End seal and bonnet blade guides to be UHMW-PE.
 - d. Magnetic Reed Switch, SPST, Normally Open, NEMA 6 IP67, CSA Approved, 24-240 Volts AC 50/60Hz, 3 wire Triac output, 4 AMP Max Inductive @ 50% duty cycle, 2 Amps max continuous, LED indication light, 9 foot PVC cable.
 - e. Manufacturer: Salina Vortex or approved equal.
 2. (1) Flexible Transition from pant leg to Feeder
 3. Volumetric Screw Feeder:
 - a. Provide a volumetric screw feeder to accurately and reliably meter Hydrated Lime from the feed hopper to the pneumatic transfer line through the feed funnel described below.
 - b. The volumetric feeder body shall be fabricated of not less than 10 gauge 304 stainless steel. The lower portion of the hopper shall be not less than 70 degrees to facilitate flow of the dry product with varying degrees of angle of repose to the ensuing screw feeder.
 - c. The drive shall be mounted to the feeder body with a stainless steel adapter having a double lip seal to seal the feed section of the hopper from the feeder drive.

- d. The screw auger shall be direct driven by a minimum ½ HP, 56C frame motor and a heavy duty right angle gear reducer. Maximum auger speed shall not exceed 90 RPM. Light-weight gear motors and or chain drives shall not be used.
 - e. The screw auger shaft shall be supported by dual, heavy duty bearings.
 - f. The auger shall be 304 stainless steel and of the solid shaft design. Open helix screws shall not be considered.
 - g. In order to optimize accuracy and repeatability of polymer feed, the auger shall maintain even flow of Hydrated Lime to the metering screw by a concentric conditioning helix.
 - h. The volumetric feeder design shall allow the motor, gear reducer and auger to be removed as a single unit or the hopper shall provide an access hatch for accessing, removing and replacing the auger. Accessing the hopper from the storage section shall not be required.
 - i. The screw feeder shall be sized to supply Hydrated Lime at a feed rate of 53 pounds per hour based on 35 #/CF.
 - j. All welds shall be ground & polished smooth and passivated.
 - k. The volumetric feeder shall be the Barracuda series by VeloDyne.
4. Mix Tank:
- a. Capacity: 50 Gallons
 - b. Construction: FRP
 - c. Water Panel Inlet Piping: (Mounted on Silo Wall with fiberglass unistrut and ss hardware)
 - 1. (1) Isolation Ball Valve
 - 2. (1) Solenoid Valve
 - 3. (1) Water Flow Meter
 - 4. (1) Water Rate Adjustment Valve

5. (1) Pressure Gauge (0-160 PSI)
 6. Piping & Fittings: Sch. 80 PVC
- d. Mixer:
1. 1/4 HP Motor
 2. Stainless Steel Shaft w/ 4" Impeller
- e. Tank Discharge Piping:
1. (1) Isolation Ball Valve
 2. Overflow Line
 3. Drain Line
- E. Feed Train #2 : Location : Existing Silo
1. (1) Flexible Transition from pant leg to Feeder
 2. Volumetric Screw Feeder:
 - a. Provide a volumetric screw feeder to accurately and reliably meter Hydrated Lime from the feed hopper to the pneumatic transfer line through the feed funnel described below.
 - b. The volumetric feeder body shall be fabricated of not less than 10 gauge 304 stainless steel. The lower portion of the hopper shall be not less than 70 degrees to facilitate flow of the dry product with varying degrees of angle of repose to the ensuing screw feeder.
 - c. The drive shall be mounted to the feeder body with a stainless steel adapter having a double lip seal to seal the feed section of the hopper from the feeder drive.
 - d. The screw auger shall be direct driven by a minimum ½ HP, 56C frame motor and a heavy duty right angle gear reducer. Maximum auger speed shall not exceed 90 RPM. Light-weight gear motors and or chain drives shall not be used.
 - e. The screw auger shaft shall be supported by dual, heavy duty bearings.

- f. The auger shall be 304 stainless steel and of the solid shaft design. Open helix screws shall not be considered.
- g. In order to optimize accuracy and repeatability of polymer feed, the auger shall maintain even flow of Hydrated Lime to the metering screw by a concentric conditioning helix.
- h. The volumetric feeder design shall allow the motor, gear reducer and auger to be removed as a single unit or the hopper shall provide an access hatch for accessing, removing and replacing the auger. Accessing the hopper from the storage section shall not be required.
- i. The screw feeder shall be sized to supply Hydrated Lime at a feed rate of 53 pounds per hour based on 35 #/CF.
- j. All welds shall be ground & polished smooth and passivated.
- k. The volumetric feeder shall be the Barracuda series by VeloDyne.

F. Train #3 : Location : Existing Building

- 1. Vacuum Conveyor system:
 - a. Capacity: 1280 #/ hr to day tank
 - b. Horizontal carbon steel frame with shop applied interior and exterior coatings.
 - c. Inline filter with quick opening front and replaceable filter element
 - d. Discharge silencer
 - e. Vacuum switch NEMA 4 enclosure
 - f. Vacuum gauge
 - g. Vacuum relief valve
 - h. Air operated vacuum breaker valve with single solenoid air control valve
 - i. Factory mounted PD blower: 5hp 230/460 v 3 PH 60 cycle with TEFC enclosure.
 - j. V belt drive

2. Vacuum pick up extension for receiving product from volumetric feeder.
 - a. Carbon steel Construction
 - b. 2" sch. 10 pipe probe with flow adjustment sleeve and thumbscrew
 - c. Air inlet screen
 - d. Coated epoxy interior STEEL IT polyurethane exterior
3. Conveyance line: (Approximated. Contractor shall provide complete length of conveyance line as shown on the drawings).
 - a. 2" schedule 10 stainless steel pipe
 - b. 110 ft. horizontal
 - c. 10 ft. vertical
 - d. 5 elbows
 - e. 2" sch. 10 stainless steel 90 degree sweep 24" CLR
4. Filter receiver 17" Hg vacuum service
 - a. 32 sq. ft. 16 oz. singed polyester bottom loading filter media with carbon steel support cage
 - b. Carbon steel bag housing with mounting flange with shop applied interior and exterior coatings.
 - c. 60 degree hopper with flanged product discharge
 - d. Rotary discharge valve: 0.27 cu/ft. per revolution
 - e. Cast iron housing
 - f. 8 vane
 - g. 14 RPM
5. Day Hopper:
 - a. Capacity: 36 ft³ storage

- b. Construction 304 SS
 - c. High/Low Level sensor: Tuning Fork
 - d. Maintenance gate: Manual Hand crank
6. Volumetric Screw Feeder:
- a. Provide a volumetric screw feeder to accurately and reliably meter Hydrated Lime from the feed hopper to the pneumatic transfer line through the feed funnel described below.
 - b. The volumetric feeder body shall be fabricated of not less than 10 gauge 304 stainless steel. The lower portion of the hopper shall be not less than 70 degrees to facilitate flow of the dry product with varying degrees of angle of repose to the ensuing screw feeder.
 - c. The drive shall be mounted to the feeder body with a stainless steel adapter having a double lip seal to seal the feed section of the hopper from the feeder drive.
 - d. The screw auger shall be direct driven by a minimum ½ HP, 56C frame motor and a heavy duty right angle gear reducer. Maximum auger speed shall not exceed 90 RPM. Light-weight gear motors and or chain drives shall not be used.
 - e. The screw auger shaft shall be supported by dual, heavy duty bearings.
 - f. The auger shall be 304 stainless steel and of the solid shaft design. Open helix screws shall not be considered.
 - g. In order to optimize accuracy and repeatability of lime feed, the auger shall maintain even flow of Hydrated Lime to the metering screw by a concentric conditioning helix.
 - h. The volumetric feeder design shall allow the motor, gear reducer and auger to be removed as a single unit or the hopper shall provide an access hatch for accessing, removing and replacing the auger. Accessing the hopper from the storage section shall not be required.
 - i. The screw feeder shall be sized to supply Hydrated Lime at a feed rate of 53 pounds per hour based on 35 #/CF.

- j. All welds shall be ground & polished smooth and passivated.
- k. The volumetric feeder shall be the Barracuda series by VeloDyne.

7. Mix Tank:

- a. Capacity: 50 Gallons
- b. Construction: FRP
- c. Water Panel Inlet Piping: (Mounted on Wall)
 - 1. (1) Isolation Ball Valve
 - 2. (1) Solenoid Valve
 - 3. (1) Water Flow Meter
 - 4. (1) Water Rate Adjustment Valve
 - 5. (1) Pressure Gauge (0-160 PSI)
 - 6. Piping & Fittings: Sch. 80 PVC
- d. Mixer:
 - 1. 1/4 HP Motor
 - 2. Stainless Steel Shaft w/ 4" Impeller
- e. Tank Discharge Piping:
 - 1. Isolation Ball Valve
 - 2. Overflow Line
 - 3. Drain Line

8. Transitions

- a. Provide a flexible transition required to interconnect volumetric feeder to silo discharge while reducing vibration transfer from the bin activator to the process equipment.

- b. Provide rigid transitions as required to interconnect volumetric feeder to the flexible transition at the silo discharge.

G. Controls

1. Water System Control Panel

a. Panel Features:

1. Enclosure: NEMA 4 X 304 Stainless Steel
2. Incoming Power Requirements: 480 VAC/3pH/60Hz
3. Main Disconnect
4. Transformer
5. Relay Logic
6. UL508A Certified and Labeled.

b. Control Switches: *(Located on Panel)*

1. System Local/Off/Remote
2. Rotary Valve On/off/Auto
3. Feeder On/Off/Auto
4. Dilution Valves On/Off/Auto
5. Mixer On/Off/Auto
6. Vacuum Conveyor Blower Local/Off/Remote

c. Numeric Displays: *(Located on Panel)*

1. Feeder VFD Actual Speed (0-100%)

d. Status Indications: *(Located on Panel)*

1. Running/Open Indication:

a. Feeder

- b. Dilution Valves Open
 - c. Mixer
 - d. Vacuum conveyor
 - e. Alarm Indications:
 - 1. Feeder Fault
 - 2. Mix Tank High Level
 - 3. Mix Tank Low Level
 - 4. Day hopper high level
 - 5. Day hopper low level
 - 6. Mixer Overload
 - 7. Vacuum conveyor Fault
- 2. Lime System PLC Control Panel:
 - a. Panel Features:
 - 1. Enclosure: NEMA 4 X 304 Stainless Steel
 - 2. Incoming Power Requirements: 480 VAC/3pH/60Hz
 - 3. Main Disconnect
 - 4. Transformer
 - 5. HMI Touchscreen
 - 6. PLC– Allen Bradley Micrologix
 - 7. UL508A Certified and Labeled.
 - b. Control Switches: *(Located on Panel)*
 - 1. System Local/Off/Remote
 - 2. Bin Activator Jog/Off/Auto

3. Rotary Valve
 4. Diverter Valve open/closed
 5. Feeders On/Off/Auto
 6. Dilution Valves On/Off/Auto
 7. Mixers On/Off/Auto
 8. Dehumidifier On/Off
- c. Numeric Displays: *(Located on Touch Screen)*
1. Feeders VFD Actual Speed (0-100%)
- d. Status Indications: *(Located on Touch Screen)*
1. Running/Open Indication:
 - a. Bin Activator
 - b. Feeders
 - c. Dilution Valves Open
 - d. Mixers
 - e. Vacuum conveyor blower
 - f. Dehumidifier running
 2. Alarm Indications:
 - a. Silo High Level
 - b. Silo Reorder Level
 - c. Silo Low Level
 - d. Bin Activator Overload
 - e. Rotary Valve Overload

- f. Day Bin High level
- g. Feeders Fault
- h. Mix Tanks High Level
- i. Mix Tanks Low Level
- j. Diverter valve overload
- k. Mixers Overload

PART 3 EXECUTION

3.01 Installation

- A. The contractor shall assume full responsibility for installation of the Hydrated Lime system, including the sub-assembly of major components, field piping, interconnecting wiring and all supports and miscellaneous hardware not specifically stated herein. This work shall include bringing sources of power, and compressed air (if required) to the system supplier's termination points.

3.02 Manufacturer's Representative Services

- A. Manufacturer's factory representative shall remain on site to observe installation and operation of equipment and advise personnel for the minimum of days specified below.
- B. Installation oversight, start up and certification of installation – (qty. 5) 8 hour days.
- C. Training of buyer's personnel – (qty. 1) 8 hour day.

END OF SECTION

SECTION 11335

CHEMICAL FEED EQUIPMENT SYSTEMS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The contractor shall furnish and install chemical feed equipment and accessories as indicated on the Drawings and as specified herein.

1.02 SUBMITTALS

- A. Submit Shop Drawings, Product Data, and installation instructions in accordance with Section 01340.

1.03 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01340 and 01700.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle equipment according to the provisions of Sections 01600.

1.05 WARRANTY

- A. Provide a one year warranty for all equipment and tanks.

1.06 MANUFACTURER'S REPRESENTATIVE

- A. Furnish the services of a qualified equipment manufacturer's representative(s) in accordance with Sections 01400 and 01600.

PART 2 PRODUCTS

2.01 METERING PUMPS

- A. Sodium Hypochlorite addition system: Sodium hypochlorite addition systems are used for oxidation and disinfection and shall consist of the following components:
 1. Two (2) panels with four (4) metering pumps with adjustable stroke frequency from 0% to 100% in increments of 1% via the stroke length knob. Rated for 3.413 gph@101 psig for oxidation and rated for 1.839 gph @101 psig for disinfection. Two metering pumps shall be mounted per panel. Pumps shall

CHEMICAL FEED EQUIPMENT SYSTEMS

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have auto-degassing liquid ends. LCD display shall have output in GPH with total in gallons. Power requirement 120VAC/1Phase/60 Hz. Meter pumps shall be Gamma/X series with skid system by ProMinent or approved equal.

- B. Fluorosilicic Acid System: Fluorosilicic acid addition systems are used for disinfection and shall consist of the following components:
1. One panel with two (2) metering pumps with adjustable stroke frequency from 0% to 100% in increments of 1% via the stroke length knob. Rated for .896 gph@101 psig. LCD display shall have output in GPH with total in gallons. Power requirement 120VAC/1Phase/60 Hz. Meter pumps shall be Gamma/X series with skid system by ProMinent or approved equal.

2.02 SKID-MOUNTED FEED SYSTEM

- A. The metering pump skid shall contain the following:
1. Polypropylene or polyethylene flat sheet, suitable for wall-mounting.
 2. Metering pumps
 3. Calibration columns
 4. Pulsation dampeners
 5. Pressure gauges
 6. Ball valves and unions
 7. Pressure relief valves
 8. Backpressure valves
 9. Control Panel
- B. Skid: each chemical feed system shall be completely assembled, mounted, calibrated, tested, and delivered to the site on a single skid. Components to be mounted on the skid are as indicated on the drawings and shall include the metering pumps, calibration column, piping, valves, piping accessories (pulsation dampeners, strainers, back pressure valves, pressure relief valves, etc.), and wiring integral to the skid. The chemical metering pump manufacturer shall be responsible for providing all equipment, valves and piping within the skid boundary.
- C. Calibration Columns:

1. Provide one, clear plastic calibration chamber with vent for use in calibrating the metering pumps.
2. The chamber shall be sized to give adequate capacity for a minimum 30 second draw down test.
3. The scale shall give direct readings in mL and GPH without the need for calculations.
4. The calibration chamber shall be piped and valved so that each pump shall be able to utilize the calibration chamber without interfering with the operation of the other pumps.
5. The top of the chamber shall have a threaded fitting to allow for piping to a common vent.

D. Pulsation Dampeners:

1. Shall be of the single diaphragm design, capable of arresting water hammer in the pump discharge lines created by the metering pumps.
2. Materials of construction of diaphragm and body shall be corrosion resistant to the chemical fluid pumped.
3. Provide one dampener on the discharge side of each metering pump.
4. Each pulsation dampener shall include an integral pressure gauge.
5. Pulsation dampeners shall be sized appropriately for each pump to remove a minimum of 95% of the pulsations. The manufacturer shall provide calculations to verify sizing if requested by the ENGINEER.

E. Backpressure/Antisiphon and Pressure Relief Valves:

1. Adjustable diaphragm backpressure sustaining/Antisiphon type valve installed on pump discharge header and set at location recommended by manufacturer. Materials to be suitable for rated chemical service.
2. One additional matching valve to be provided at acid injection point.
3. Adjustable diaphragm pressure relief valve installed externally on pump discharge header and set at location recommended by manufacturer. PRV required for each pump mounted on feed system. Materials to be suitable for respective chemical service.

F. Piping, Valves and Appurtenances:

1. Skid piping shall be Schedule 80 PVC. Cement shall be as recommended by the pipe manufacturer, suitable for the chemical services specified.
2. True-union ball valves shall be provided for isolation of major equipment. Seals shall be compatible with the chemical being pumped.

G. Termination Box:

1. All power cords, signal input cables, and output cables shall be pre-wired at the factory, utilizing appropriate conduit, ending at a termination box within the boundary of the skid panel.

2.03 PROTECTIVE CURTAIN WALLS

- A. Cutrain walls shall be manufacturer by Goff's Enterprises, Inc. 1228 Hickory St. Pewaukee, WI, (262) 691-4998, www.goffscurtainwalls.com or approved equal.
- B. Provide #2 stainless tooth grommets on 1' centers, 14 oz. reinforced vinyl white top section, 20 mil double polished clear window section, 14 oz. reinforced colored vinyl section, and chain weighted lower hem.
- C. Provide industrial vinyl suitable for the chemicals the protective curtain walls are shielding from general operating areas.
- D. All seams shall be double lock stitched. All sections shall be joined together using acid-proof thread. Hook and loop fasteners shall allow adjacent panels to be easily attached to one another.
- E. Provide 16 gauge channel track system with dual wheeled carrier stainless steel roller hooks, 1' on center along top of the curtain, end wall brackets, and universal mounting hardware.
- F. Widths and heights as shown on the drawings.

2.04 HYDROCHLORIC ACID AND FLUOROSILICIC ACID DRUMS

- A. Provide six (6) 55 gallon translucent polyethelene tanks with covers and 2.5 gallons graduation. (USA Bluebook #115 , Stock #27379 .)

2.05 POLYMER FEED SYSTEM

A. Description:

1. Provide liquid polymer blending system consisting of polymer mixing chamber, neat polymer metering pump, dilution water inlet assembly,

solution preparation and aging tank, solution metering system, and control panel.

2. System shall be VeloBlend Model VMB-5P-1200-D-0-A-1 Liquid Polymer Blending System manufactured by Velocity Dynamics, Inc.(Velodyne),Boulder,CO,(303)-530-3298,www.polymersolution.com,or approved equal.

B. Performance

1. Pump Capacity: 0.25 to 5 gph.
2. Dilution water Capacity: 2 to 20 gph

C. Operation

1. Provide 120 VAC, 1 phase, 60 Hz power to the control panel.
2. Provide the following control panel features:
 - a. Type 304 Stainless steel enclosure (NEMA 4X FRP) Contain:
 - i. Control circuit protection
 - ii. Control relays
 - iii. Power supplies
 - iv. Grounding blocks
 - v. Numbers terminal blocks
 - vi. Wire labels, shrink-tube type
 - b. The following interface signals connected to terminals for field connection:
 - i. System In Remote Status (dry contact output)
 - ii. System Running Status (dry contact ouput)
 - iii. Common Alarm (dry contact ouput)
 - iv. LED Display Metering Pump Rate
 - v. Low Water Differential Pressure (dry contact output)
 - vi. Low Polymer Flow (dry contact output)
 - vii. Start/Stop Command (input)
 - viii. Pump Pace Command (4-20 mA input)

D. Multi-Zone Hydro-Mechanical Mixing Chamber

1. Provide a reliable polymer blending system.
2. Provide a hydro-mechanical blending device that operates on plant water pressure alone at no less than 30 psid, produces its mixing energy independent of plant water pressure through a variable intensity, controllable stainless steel mechanical mixer, and produces high, non-

damaging mixing energy at each flow rate without damage to the polymer's molecular structure.

3. Prevent polymer build-up by maintaining a high velocity in the entire mixing chamber.
4. Provide clear Lexan for the mechanical and non-mechanical mixing zones to view the mixing action and blending effectiveness. Do not use acrylic chambers or opaque PVC pipe.
5. Provide helicoil inserts for increased strength on holes tapped in plastic.
6. Provide mixing chamber with rated pressure of 100 psi.
7. Provide a pressure relief on the mixing chamber, adjustable between 25 and 100 psi. Provide brass valve, Viton and Teflon internals.
8. Provide a variable speed stainless steel mechanical mixing impeller that produces both axial and radial flow to optimize mixing effectiveness and to effectively inducing high, non-damaging mixing energy over the systems full flow range. Do not use plastic impellers.
9. Control the impeller by an SCR motor controller driven by a wash-down duty motor.
10. Provide a mixer drive shaft sealed by a mechanical seal that has an integrally mounted and factory plumbed seal flushing valve. Provide a drain port behind the seal in the mixing chamber to drain the polymer solution in case of a seal failure. Ensure the seal is easily accessible for replacement. Do not use systems without a seal flushing system.
11. Provide bearings external from the mixing chamber. Do not use internal bearings.
12. Do not provide systems that rely on high shear and or constant speed impellers or that rely on close tolerances for blending.
13. Systems That Rely Solely on Water Pressure to Create Mixing Energy
 - a. Do not provide systems that rely solely on water pressure to create mixing energy unless the system is provided with an integrally mounted dilution water booster pump and meets the above polymer mixing criteria.

- b. Provide a VFD motor controller to control the pressure and mixing energy generated by the booster pump.
 - c. Provide multi-staged, stainless steel booster pumps that generate 75 psid independent of water supply pressure, which is verified at system start-up. In the event the booster pump cannot produce 75 psid of water pressure, install a properly sized booster pump at supplier's expense.
 - e. Do not provide systems that rely solely on plant water pressure to create mixing energy.
14. Neat Polymer Check Valve
- a. Provide a neat polymer check valve that isolates neat polymer from dilution water.
 - b. Provide an open, unobstructed path to the valve seat.
 - c. Valve body: Teflon with Viton seals.
 - d. Valve poppet and spring: stainless steel that prevents polymer from flowing through the spring, causing build-up and plugging. Do not use plastic spring covers.
 - e. Ensure the valve is readily accessible for cleaning and does not require tools for removal, cleaning or replacement. Do not use conventional check valves, valves that rely on ball seals, check valves that are installed inside the mixing chamber, or that require mixing chamber disassembly for servicing.
 - f. Attach the locking pin used to hold the valve in place to the mixing chamber with a lanyard.

G. Dilution Water Assembly

- 1. Monitor the dilution water flow rate by a Rotameter type flow meter having a range specified. Provide a union on the Rotameter to allow easy removal for cleaning.
- 2. Ensure the valve is readily accessible for cleaning and does not require tools for removal, cleaning or replacement.
- 3. Provide a differential pressure type low water differential pressure alarm. Provide a switch that is adjustable between 10 and 25 psid.

4. Provide a 1 inch stainless steel liquid filled pressure gauge to monitor dilution water inlet pressure.

H. Progressive Cavity Neat Polymer Metering Pump

1. Provide neat polymer metering pump integrally mounted on each system skid, with the range specified.
2. Provide a calibration column with isolations valves having Viton o-rings. Calibrate the column for a one minute draw-down at full pump capacity and read in gallons per hour and milliliters.
3. Provide a pressure relief on the discharge of the metering pump, adjustable between 0 and 160 psi. Factory plumb the valve back to the suction of the pump. Provide a stainless steel or PVC body valve with stainless steel, Viton and Teflon internals. Do not use brass pressure relief valves.
4. Provide a pressure gauge with diaphragm isolator to monitor polymer line pressure.
5. Provide a thermal type loss of polymer flow sensor.

I. Solution Discharge Assembly

1. Provide a 1 inch stainless steel liquid filled pressure gauge to monitor system discharge pressure.

J. Equipment Skid

1. Provide system frame of rugged Type 304 stainless steel construction. Do not use mild steel. Rigidly support piping.
2. Do not exceed pump suction of 5 inches from the bottom of the skid.
3. Do not exceed overall system dimensions of 34 inches wide by 30 inches deep by 72 inches high.

K. Equipment Appurtenances

1. Provide galvanized steel, cadmium plated, or Type 316 stainless steel bolts, nuts, anchors, washers and other types of supports necessary for the installation.
2. Nameplates
 - a. For each major item of equipment provide the manufacturer's

name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

L. Piping

1. Backflow Preventer
 - a. Provide backflow prevention devices or air gaps on tank fill lines in accordance with NAPHCC NSPC.
2. Chemical Solution Piping
 - a. Incorporate provisions to allow solution piping to be conveniently and safely bled of trapped air and minimize infiltration of air bubbles.
 - b. Provide chemical solution piping in accordance with Section 15000 PIPING AND VALVING.
3. Plumbing
 - a. Provide water piping, drain, and waste and vent piping in accordance with specifications.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Installation of all chemical feed equipment, tank, and accessories shall be in accordance with Drawings and manufacturer's instructions.
- B. After installation is complete, a qualified factory representative shall place each system in operation, conduct a complete function check and make all necessary adjustments for regular service in accordance with Section 01600.

3.02 TESTING AND DEMONSTRATION

- A. Start-up, test and demonstrate pumps, equipment and accessories in accordance with Section 01600.
- B. Provide instruction to Owner in accordance with Section 01600. Provide 4 hours of instruction to Owner by manufacturer's representative.

END OF SECTION

SECTION 15000

PIPING AND VALVING

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Pipe and fittings
- B. Valves
- C. Wall pipe and sleeves
- D. Adaptors and couplings
- E. Labels

1.02 REFERENCE STANDARDS

- A. National Standard Plumbing Code
- B. AWWA C200, C208, C206, C207, C205, C203, C214 and AWWA Mill for steel pipe, fittings and joints, coatings and installation.
- C. AWWA C900, C110, C111, ASTM D1785, D2241, F477, D3139, D1784, ANSI/ASTM 2321, D2729, ASTM C564 for PVC water and sewer pipe, fittings, joints, gaskets and installation.
- D. ASTM A120 for galvanized steel pipe.
- E. AWWA C509 and C515 for gate valves.
- F. ANSI/AWWA C104/A21.4 - Cement - Mortar Lining for Ductile Iron Pipe and Fittings for Water.
- G. ANSI/AWWA C110/A21.10 - Ductile Iron and Gray Iron Fittings.
- H. ANSI/AWWA C111/A21.11 - Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
- I. ANSI/AWWA C115/A21.15 - Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.
- J. ANSI/AWWA C150/A21.50 - Thickness Design of Ductile Iron Pipe.
- K. ANSI/AWWA C151/A21.51 - Ductile Iron Pipe Centrifugally Cast.

- L. ANSI/AWWA C153/A21.10 - Ductile Iron Compact Fittings, 3 in. through 16 in. for Water and other liquids.
- M. ANSI/AWWA C600 - Installation of Ductile Iron Water Mains and their Appurtenances.
- N. ASTM D2774 – Recommended Practice for Underground Installation of Thermoplastic Pressure Piping and PVC Pipe.
- O. ASTM D3034 - Specification for Sewer Pipe and Fittings.
- P. ASTM D3212 – Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- Q. ASTM D2564 – Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
- R. ASTM D2321 – Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
- S. ANSI B31.1 – Code for Pressure Piping.
- T. ASTM D1248 – Polyethylene Plastics molding and Extrusion Materials.
- U. ASTM D2837 – Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
- V. ASTM D3350 – Polyethylene Plastic Pipe and Fitting Materials.
- W. ASTM B88-96 Seamless Copper Water Tube.
- X. All Pipes and Piping procedure shall be provided and install in accordance with the “City of Dover Water/Wastewater Handbook” City of Dover Public Utilities Department effective March 22, 2010. If there will any discrepancy between this Specification, drawings and the City of Dover Standard Specification, the Standard Specification City of Dover should be followed in first priority.

1.03 QUALITY ASSURANCE

- A. Materials shall conform to manufacturer's specifications and instructions.

1.04 SUBMITTALS

- A. Submit samples, manufacturer's product data and installation instructions in accordance with Section 01340.

- B. Submit manufacturer's technical Product Data, installation instructions, and directions for adjustment for all Products required to complete Work of this Section.
- C. Submit Shop Drawings: Indicate pipe materials and fittings used, valves, joining methods, all equipment of this Section, installation and piping connections for all piping systems to be installed under this Section.

1.05 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Sections 01340, 01700, and 11000.
- B. Maintenance Instructions: Include maintenance instructions and procedures, and spare parts lists.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle Products to site under provisions of Section 01600.
- B. Deliver and store valves in shipping containers, with labeling in place.
- C. Provide temporary protective coating on valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

PART 2 PRODUCTS

2.01 MANUFACTURER'S

- A. Where manufacturer's products are specified, it is for the purpose of establishing a standard of quality and construction.
- B. Equivalent products of other manufacturer's may be substituted under the provisions of Section 01340.

2.02 DUCTILE CAST IRON PIPE (DIP)

- A. Ductile iron water mains shall be class 52, cement mortar lined double thickness with a bituminous seal coat, mechanical joint or rubber gasket push-type joints, bituminous coated on the exterior in accordance with ANSI A-21.51 (AWWA C151) and ANSI A-21.11. Interior flanged piping shall be Class 53. All piping shall withstand a minimum working pressure of 150 psig. Pipe shall not be more than 18 or 20 feet in nominal length. Ductile iron pipe shall be as manufactured by Griffin Pipe Products Co., US. Pipe, Tyton or approved equal.

- B. All buried pipe shall receive an outside bituminous seal coat and cement interior lining in accordance with AWWA C104. Above ground or exposed piping shall be uncoated and suitable for painting.
- C. Above ground or exposed ductile cast iron pipe shall be flanged in accordance with ANSI A21.15. Buried ductile cast iron pipe shall have push-on joints or mechanical joints. Rubber gaskets shall conform to AWWA C111 for mechanical and push-on joints.
- D. Fittings shall be ductile iron, compact body, in accordance with ANSI 21.53 and rated for 350 PSI working pressure as manufactured by Tyler Pipe, U.S. Pipe, or approved equal. Fittings shall be provided with mechanical joint ends in accordance with ANSI A 21.11 and double cement lined with bituminous seal coating inside and out in accordance with ANSI 21.4 edition.
- E. All gaskets between flanged connections and fittings shall be non-asbestos composition minimum thickness of 1/8", and shall be coated with thread lubricant prior to making up joints. Flange bolts, nuts and washers shall be of mild steel with sound, well-fitted threads, the nuts shall be cold-punched, hexagonal, trimmed, and chamfered. Heads, nuts and threads shall be United States standard sizes. Bolts shall be of such length as to project one-quarter inch beyond the nut when the flanged joint with gasket is assembled.
- F. All buried joints shall be restrained with mechanical joint restraint (Megalug Series 1100 by EBAA Iron or equal) or push-on bell restraint (Megalug Series 1700 by EBAA Iron or equal).

2.03 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

- A. The pipe shall be made from polyethylene resin compound qualified as Type III, Category 5, Class C, Grade P34 in ASTM D1248. This material shall have a long-term hydrostatic strength of 1600 psi when tested and analyzed by ASTM D2837.
- B. The raw material shall contain a minimum of 2%, well dispersed, carbon black.
- C. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same specification and from the same raw supplier.
- D. The minimum cell classification shall be PE 345464C for PE 3408 materials per ASTM D3350.
- E. Compliance with the requirements of this paragraph shall be certified in writing by the pipe supplier, upon request.

- F. The pipe shall be Sclairpipe DR9 as manufactured by KWH Pipe, Ltd.; Phillips Driscopipe or approved equal.

2.04 STAINLESS STEEL PIPE

- A. Stainless steel pipe carrying liquids shall be Schedule 10 or Schedule 40 as shown on the drawings. All liquid carrying pipe shown as “SS” less than 4” in diameter shall be 304L Schedule 40 with screwed fittings. All pipe and fittings shown as “SS” 4” and greater shall be 304L Schedule 10 150 lb. rated with flanged connections (Vanstone or equal) or welded. Stainless steel lime carrier pipe shall be 304L SCH 10.

2.05 PVC GRAVITY PIPE

- A. PVC pipe compound shall conform to ASTM D1784. “Standard Specification for Rigid Polyvinyl Chloride (PVC) Compounds”.
- B. PVC pipe eight inches and larger shall conform to ASTM D3034, SDR 35, Type PSM, with integral bells meeting requirements of ASTM D3212. Rubber gaskets shall conform to ASTM F477.
- C. Fittings for PVC pipe eight inches and larger shall conform to ASTM D3034, SDR 35, Type PSM. Joints shall meet requirements of ASTM D3212 and gaskets shall conform to ASTM F477.
- D. Pipe and fittings shall be manufactured by CertainTeed Corporation; J-M Manufacturing Company, Inc. or equal.

2.06 PVC PRESSURE PIPE

- A. Pipe and Fittings Less Than 4 inch Diameter
 - 1. Pipe shall meet requirements of ASTM D1785, Schedule 40, Schedule 80, SDR 17, or SDR 21 where indicated. All SDR 21 pipe and fittings shall be bell and spigot type.
 - 2. Pipe shall be manufactured of Type 1, Grade 1 PVC materials conforming to ASTM D1784, minimum cell classification 12454; PVC pressure pipe for plumbing systems, if required, is further specified in other sections. Piping for chemical lines shall be CPVC.
 - 3. Schedule 40 or Schedule 80 piping systems shall be joined by socket-weld connections except where connecting to unions, valves, and equipment with threaded connections that may require future disassembly. Connections at those points shall be threaded and back-welded.

4. The schedule rating for the fittings shall not be less than that for the associated pipe. Fittings shall be ASTM D1784, minimum cell classification 12454, PVC conforming to the requirements of ASTM D2467, socket type.
 5. PVC Solvent Cement: Socket connections shall be joined with PVC solvent cement conforming to ASTM D2564. Manufacture and viscosity shall be as recommended by the pipe and fitting manufacturer to assure compatibility. Joints shall be prepared with primers conforming to ASTM F656 prior to cementing and assembly.
- B. Pipe and Fittings 4 inch Diameter to 24 inch
1. Pipe shall conform to AWWA C900 or C905 and shall be plain end or gasket bell end, Pressure Class 150 (DR 18), with cast-iron-pipe-equivalent OD.
 2. Joints for pipe shall be push-on joints as specified in ASTM D3139.
 3. Joints between pipe and fittings shall be compression-type joints/mechanical-joints as respectively specified in ASTM D3139 and AWWA C111/A21.11.
 4. Each joint connection shall be provided with an elastomeric gasket suitable for the bell or coupling with which it is to be used. Gaskets for push-on joints for pipe shall conform to ASTM F477. Gaskets for compression-type joints/mechanical-joints for joint connections between pipe and fittings shall be as specified in AWWA C111/A21.11. All buried joints shall be restrained with Mega-Lug or equal. Concrete restraint is also required as shown on the drawings.
 5. Fittings shall be ductile iron conforming to AWWA C110/A21.10 or AWWA C153/A21.53. Fittings shall have pressure rating at least equivalent to that of the pipe. Fittings shall have mechanical joint connections. Fittings shall have an epoxy coating on the interior and exterior surfaces in accordance with AWWA C116/A21.16 or cement-mortar lining in accordance with AWWA C104/A21.4, standard thickness. Buried fittings not having an epoxy coating shall receive a bituminous seal coat on the exterior surfaces in accordance with AWWA C151/A21.51.
 6. Pipe and fittings shall be manufactured by CertainTeed Corporation, J.M. Manufacturing Company, Inc., or equal.
- C. Push-on buried joints shall be restrained with Bell Restraint Series 2800 (for C905 pipes) and Series 1500 (for C900 pipes) manufactured by EBAA Iron or equal. Concrete restraint is also required as shown on the drawings. Mechanical joints shall be restrained with Mega-Lug Series 2000PV by EBAA Iron or equal.

2.07

GATE VALVES

A. Valves

1. Gate valves shall be iron body, rubber-encapsulated resilient seat, non-rising stems and **shall open by turning counter clockwise**. Flanged end valves, as shown on the drawings, shall be wheel operated with non-rising stems unless stated otherwise on the drawings. Wheel operators shall have arrows to indicate opening direction. Buried valves shall be mechanical joint with non-rising stems. Gate valves shall be in conformance with AWWA C-509 or C-515, latest edition, and be rated for 200# PSI working pressure. Gate valves shall be as manufactured by, American Flow Control, Series 2500, Mueller Company, Model A-2360, U.S. Pipe or approved equal.
2. Buried 16" valves shall be installed horizontally to provide freeze protection. Valves shall be provided with bevel gear assemblies. An additional bearing support shall be provided on the extreme end of the gate valve stem. All gears shall have machine cut teeth and be furnished with grease cases. Bevel gear stems shall be provided with 2" square operating nuts.

B. Valve Key

1. The Contractor shall furnish two five foot long valve operating wrenches, Mueller A-24510 or equal.

C. Valve Boxes

1. Valve boxes shall be two-piece screw type with 5¼-inch shafts. Valve boxes shall be adjustable. Lids shall be extra deep with two holes and the word "WATER" cast in the upper surface. Valve box assemblies shall be as manufactured by Tyler/Union, Bingham & Taylor, QWP or approved equal.
2. Installation shall be such that when setting a valve box in place, the base should rest two or more inches above the flanged joint of the cover. The top of the operating nut should be no higher than the hub or upper part of the valve box base where it connects to the center section. This location for the valve box will leave ample space all around the valve, prevent the box from touching the valve in any way, and permit free access to the operating nut with a valve wrench.

2.08 AIR RELEASE VALVES

- A. Air release valves used to vent pressure lines shall be short body valve, size ¾" NPT inlet and 1/8" orifice.
- B. Body and cover shall be ASTM A126 Class B Cast Iron. The internal parts shall be stainless steel.

- C. All release valves shall be Model 34AR-18 manufactured by Cla-Val Co or equal.

2.09 CHECK VALVES

A. HIGH SERVICE, INTERMEDIATE, AND RESIDUAL PUMPS

1. The check valve shall be installed on the discharge side of the pumps. They will slowly open when the pump starts to prevent any water hammer. They shall open on inches of differential pressure. When the pump is not running and the system pressure is higher the check valve will close drip tight and prevent return flow back through the pump.
2. The check valve shall be of the swing check design. There shall be a cushioning action provided by an outside weight and lever. This weight on the lever arm will be adjustable for varying pump conditions.
3. Valve shall be composed of a ductile iron body and cover meeting ASTM A536. The body and cover will have an NSF61 fusion bonded epoxy coating and meet C508-09 standards. It will have a ductile iron disc and arm. The shaft will be 304 SS and the seat shall be 316SS. The resilient disc shall be NBR rubber. The valve will have 150ansi flanged ends rated to 250psi.
4. The valves shall be 6" and 10" Model 585LW Outside Weight and Lever Swing Check Valve as manufactured by Cla-Val Co. Newport Beach, CA or approved equal.

B. RECIRCULATION PUMPS

1. The check valve shall be installed on the discharge side of the pumps. They will slowly open when the pump starts to prevent any water hammer. They shall open on inches of differential pressure. When the pump is not running and the system pressure is higher the check valve will close drip tight and prevent return flow back through the pump.
2. Check valve shall be swing type with screw cap access to the disc. Gaskets shall be PTFE. Seat shall be metal to metal.

2.10 PRESSURE GAUGE

- A. Liquid (Glycerin) filled pressure gauges shall be supplied with 1/2" valves with black, drawn steel cases and 4-1/2" dials. Pressure gauges shall be Model I279 - 1/2 NPT lower side connection as manufactured by Ashcroft or approved equal. The pressure

range figure interval, and gradation shall be as shown on the drawings. Provide gauge saver with elastomeric bladder to protect each pressure gauge from process fluid.

2.11 WALL SLEEVES AND WALL PIPES

- A. Pipe passing through walls, floors or other structural members shall utilize wall sleeves or wall pipes as shown on the Contract Drawings.
- B. Wall sleeves shall be steel with an intermediate waterstop flange as manufactured by Thunderline Corporation or approved equal. Sleeves shall be primed in accordance with Section 09900.
- C. All sleeves and wall pipes shall be sized to conform to the Contract Drawings.
- D. Pipe and sleeves for non-water containing structures shall be sealed with Link-Seal as manufactured by Thunderline Corporation or filled with non-shrink grout.
- E. Wall pipes for water containing structures shall be D.I.P. as manufactured by Clow Corp. or approved equal.

2.12 COPPER PIPE

- A. Above ground copper pipe shall be Type “L” hard conforming to ASTM B88-96.
- B. Underground copper pipe shall be Type “K” soft conforming to ASTM B88-96.
- C. Fittings: Wrought copper, ANSI B16.22; dielectric fittings between copper and steel pipe as manufactured by EPCO or equal.
- D. Joint material: Alloy Grade 95-5 (95% tin – 5% antimony) in wire or rod conforming to ASTM B-32 with flux as recommended by manufacturer applied to fitting and pipe.

2.13 TRANSITION COUPLINGS

- A. Transition couplings between differing piping materials, and where indicated on drawings, shall have cast iron sleeves, ductile or malleable iron glands, corrosion resistant alloy steel bolts and nuts. Glands and gaskets of appropriate type to fit pipe O.D. shall be supplied.
- B. Transition couplings shall be Smith Blair cast coupling or equal.

2.14 PIPE TAPS

- A. Provide taps for small pipe or instrument connections.

- B. Tapping sleeves shall be stainless steel as manufactured by PowerSeal, Model #3490, Mueller, or approved equal. Threads shall be protected with temporary plugs.

2.15 UNDERGROUND WARNING TAPE

- A. Pipeline detection tape shall be Lineguard Type III Detectable Tape as manufactured by Lineguard, Inc. of Wheaton, Illinois, or approved equal. The tape shall be a minimum of 2 inches wide, blue in color, imprinted with the words “Caution - Water Line Below”, and be capable of being detected with inductive methods.

2.16 BRONZE BALL VALVES

- A. Provide ball valves of the size shown on the Drawings. Bronze ball valves shall be one piece body with bronze trim and TFE seats, Nibco Model T-560-BR-Y-20 or approved equal.

2.17 PVC BALL VALVES

- A. Provide PVC or CPVC True Union ball valves with Viton/PTFE Seals.
- B. Valves to match pipe schedule.

2.18 STAINLESS STEEL BALL VALVES

- A. Provide stainless steel valves of the size indicated on the drawings. Valves shall be fully ported with all components comprised of stainless steel. Stem seal and bearing to be TFE. (Manufactured by Nibco, Neles-Jamesbury or equal).

2.19 CORPORATION STOPS

- A. Corporation stops shall be manufactured by Mueller. Corporation stops for underground connections with Conductive Compression Connection for CTS O.D. tubing shall be as manufactured by Mueller, Model H-15008, or approved equal. Corporation stops shall be spaced a minimum of 24 inches apart along the barrel of the main. A hole-type cutter shall be used to tap mains for installation of corporation stops and the coupon removed. Auger-type drills will not be allowed. Wet taps of existing water mains will have to be accomplished. Corporation stops should be located at least two feet from the pipe ends. If two insertions are made, one on each side of the main, they should be separated (measured along the pipe length) by at least one foot. Multiple insertions made on the same side of the main should be staggered 30 degrees around the circumference as well and separated by at least two feet.
- B. Corporation stops for interior connections shall be Mueller B-20045, or equal, for threaded outlet.

2.20 CURB STOPS

- A. Curb stops with female iron pipe thread, both ends, shall be as manufactured by Mueller, Model H-10291, or approved equal.

2.21 STRAIGHT COUPLINGS

- A. Straight couplings for Conductive Compression Connection for CTS O.D. tubing X male iron pipe thread shall be as manufactured by Mueller, Model H-15428, or approved equal.

2.22 CURB BOXES

- A. Curb boxes shall be screw type with arch pattern base as manufactured by Tyler/Union, 6500 Series, Bingham & Taylor, or approved equal. No recessed lids will be accepted.

2.23 YARD HYDRANTS

- A. Yard hydrants shall be manufactured by Wood Ford, Model U150M , complete with vacuum breaker. Hydrants shall be freeze proof, self-draining and suitable for 3'-6" depth of bury. All operating parts shall be brass.

2.24 SURGE RELIEF AND ANTICIPATOR VALVE

- A. Valve will be designed to act as a pressure relief and surge anticipator. It will have a normally closed high pressure pilot designed to open if the pressure exceeds the normal pressure while pumping. It will also have a low pressure pilot that is held closed as long as the system is at or above static. If there is a pressure drop, due to a power outage the low pressure pilot will open anticipating the returning high wave. The main valve cover will have a hydraulic stem valve flow limiter. On the drop in pressure this hydraulic stem valve will keep the valve from opening too far to ensure it will reseat when the pressure rises.
- B. The main valve will be globe straight body manufactured of ductile iron and have stainless trim internals. It will have a one piece stainless steel seat. No snap rings will be accepted. The valve shall be fully guided throughout its' stroke by a bearing in the seat and a bearing in the cover. It will have an NSF approved fusion bonded epoxy coating. The cover will have a locating lip. The main body will have 150 ansi flanged ends rated to 250 psi working pressure. The main valve will be packless and will have no o-rings or other packing anywhere on the disc and diaphragm assembly. The CRL relief pilot will have a 20-200psi spring range. The CRA low pressure pilot will have a 20-105 psi range. When the valve opens on a pressure drop the X102 mechanical flow limiter will keep the valve from going fully open. The manufacturer will install a gauge on the inlet for monitoring and set up. There shall be a "Y" strainer on the inlet feed to the pilot system. The

strainer will have a manual blowdown port. The pilot system will also have an enclosed site glass with a stem for visual indication of valve position.

- C. The manufacturer shall provide a direct factory employee for start up and training.
- D. The manufacturer shall warranty the valve for 3 years from date of shipment.
- E. The valves shall be a 6” model 52G-03BPYKC D.S. SSB 150A as manufactured by Cla-Val Co. Newport Beach, CA. or approved equal.

2.25 BACKFLOW PREVENTER

- A. Provide backflow preventer at the location shown on the Drawings. Backflow preventer shall be reduced pressure principle type in accordance with AWWA C511 consisting of two independently acting poppet-type check valves, an automatic pressure differential relief valve located between the two check valves; and four test cocks for field testing. Backflow preventer shall be Cla-Val Co. Model RP-2 or approved equal.

2.26 PRESSURE REDUCING VALVES

- A. Valve will be designed as a pressure reducing valve. It will be designed, maintain a constant downstream pressure regardless of inlet pressure or flow fluctuations. It will open when the downstream zone pressures drops to feed water from the high pressure side. This flow through the pressure reducing valve will be dictated by the downstream demand.
- B. The main valve will be supplied in 100-01 full ported body configuration. It will consist of three different parts; the body with seat installed with flat seat stainless machine screws, the cover with cover bearing and the disc and diaphragm assembly. The diaphragm assembly will be the only moving part. It will be ductile iron and have stainless steel trim internals. The main valve trim will include a solid one piece stainless seat, the contoured disc guide and the stainless stem. The main will have an NSF 61 fusion bonded epoxy coating on all internal and external ferrous metal surfaces. The cover of the main valve will have a locating lip for ease of maintenance and to maintain alignment of the stem within the disc/diaphragm assembly. The main valve cover fasteners will be stainless steel. The cover will be one piece. There shall be no pins in the cover for alignment. The main valve will be the packless design and shall have no orings or packing anywhere within the main valve. The main valve will have stainless steel cover bolts and nuts.
- C. The pilot control system will consist of a CRD pressure reducing pilot. The CRD will have a 20-105 psi adjustment range. The pilot control system will also contain a “Y” strainer to prevent any debris from entering the control loop. The system will also contain pilot isolation valves for maintenance and troubleshooting. The main valve

cover will have a visual valve position indicator for monitoring the valve position at any time. There shall also be gauges mounted on the inlet and outlet.

- D. The manufacturer shall provide a direct factory employee for start up and training the operations and maintenance personnel.
- E. The pressure reducing valve will be a model 12" 90G-01BPSVYKCKHKX D.S. 150ansi X101 as manufactured by Cla-Val Co., Newport Beach, CA, or equal.

2.27 DUCTILE IRON TAPPING SLEEVES

- A. Ductile Iron Mechanical Joint Tapping Sleeves shall be in accordance with the requirements of ANSI/AWWA C110/A21.10-82.
- B. Install on cleaned pipe.
- C. Sleeve shall be Mueller H-615 or equal.

PART 3 EXECUTION

3.01 PRESSURE PIPE AND VALVE INSTALLATION

- A. Below grade pipe installation shall comply with the requirements of AWWA C600 (latest revision). All pipe shall be installed according to manufacturer's written instructions. Pipe and fittings shall be carefully handled and lowered into the trench. The ends of pipe shall abut against each other in such manner that there shall be no shoulder or unevenness on the inside of the main. Use lubricant specified and supplied by pipe manufacturer and approved for water usage for proper pipe joint installation. Special care shall be taken to insure that the pipes are well bedded on a solid foundation, and any defects due to settlement shall be made good. Bell holes shall be dug sufficiently large to insure the making of proper joints. Proper and suitable tools and appliances for the safe and convenient handling and laying of pipes and fittings shall be used. Great care shall be taken to prevent the pipe wall from being damaged, and any wall damage shall be repaired to the satisfaction of the City Engineer by the Contractor. Pipe and fittings shall be thoroughly cleaned before they are laid and shall be kept clean until the acceptance of the completed work. At the close of each work day the end of the pipeline shall be tightly closed with an expansion type stopper or plug so that no dirt or other foreign substance may enter the line, and this stopper or plug shall be kept in place until pipe laying is again resumed. Whenever a pipe or fitting requires cutting, to fit into the line or to bring it to the required location, the work shall be done in a satisfactory manner so as to leave a smooth end, and without extra compensation. All cutting of pipe shall be in accordance with manufacturer's recommendation. In jointing pipe and fittings, the Contractor shall exercise particular care to insure that the outside of the spigot and inside of the bell are entirely free of oil, tar and greasy substances to insure a tight fit. All concrete required to construct buttresses behind plugs, tees, bends and other fittings and anchorages beneath horizontal or vertical bends shall

be placed as directed and/or as shown on the City of Dover, Public Utilities Standard Details.

- B. The Contractor shall verify the dimensions of all valves, fittings, equipment, etc., so that all of the pipework performed will fit together properly and conform to the general arrangement shown on the Drawings. All pipe, valves, fittings and related accessories shall be carefully examined for defects before installing and no defective pieces shall be installed. All pieces shall be thoroughly cleaned before they are installed and shall be kept clean and dry.
- C. Adjoining above grade pipe, valves and/or equipment to be joined by flanges shall be blocked and shimmed to true elevation with bolt holes in perfect alignment before bolts are inserted and tightened. Bolts shall be tightened uniformly. Drawing skewed joints into alignment by tightening flange bolts will not be permitted. All gaskets between flanged connections and fittings shall be coated with thread lubricant prior to making up joints. Flange bolts, nuts and washers shall be of mild steel with good, sound, well-fitted threads; the nuts shall be cold-punched, hexagonal, trimmed, and chamfered. Heads, nuts and threads shall be United States standard sizes. Bolts shall be of such length as to project one-quarter inch beyond the nut when the flanged joint with gasket is assembled.
- D. Piping shall be firmly and properly supported by malleable or wrought iron hangers, guides, saddles, clamps, etc., as necessary and as shown on the drawings. Concrete pedestals or piers shall be provided where indicated or required. Where drilling of anchor bolt holes becomes necessary, the Contractor shall secure permission from the Engineer prior to starting the drilling. The Contractor shall furnish and install all necessary supports, hangers, guides, saddles, clamps, etc. required to provide a complete operational facility. The type of hangers, guides, etc. shall be as shown on the drawings and as specified.
- E. During construction, the Contractor shall keep all ends of pipes or conduits, and all equipment connections, closed with caps, plugs, or wooden flange covers, so as to prevent entrance of dirt, building materials, or other foreign matter.
- F. Proper and suitable tools and equipment for the same and convenient handling and laying of the pipe and fittings shall be used in accordance with the manufacturer's standards. Pipe and fittings shall be carefully handled and lowered into position.
- G. Whenever a pipe requires cutting to fit in the line to bring it to the required location, the Work shall be done without extra compensation, in a satisfactory manner so as to leave a smooth end perpendicular to the axis of the pipe.
- H. Before any joints are actually made, the Contractor shall demonstrate to the Engineer, by making a sample joint, that the methods he will employ conform with specifications and will secure a watertight joint, and that the workmen whom he intends to use in this Work are familiar with the requirements.

- I. All laying, jointing, testing for defects and for leakage shall be performed in the presence of the Engineer. All defects in workmanship rejected by the Engineer shall be promptly corrected by the Contractor and defective material removed from the Project.
- J. The excavation in which the pipe is being laid shall be kept free from water, and no joint shall be made under water, care shall be used to secure water-tightness and to prevent damage to, or the disturbing of, the joints during the backfilling process or at any other time. After pipes have been laid and the joints have been made, there shall be no walking on or working over them except as may be necessary in tamping until there is a covering at least two (2) feet in depth over their top.
- K. A metallic lined underground warning tape shall be placed over the entire length of all buried pipe. The tape shall be placed 24" above the pipe. The tape shall be 3", color green, with the message "Buried Water Line Below". Tape shall be equal to "Seton Nameplate Corporation" detection tape printed on polyethylene with a metallic core.
- L. Before joints are made, each pipe shall be well bedded on a solid foundation and no pipe shall be brought into position until the preceding length has been thoroughly embedded and secured in place. No pipe shall be laid in wet trench conditions that preclude proper bedding, or on a frozen trench or weather conditions are unsuitable for proper installation. Any defects due to settlement shall be corrected by the Contractor at his own expense. Bell holes or coupling holes shall be dug sufficiently large to insure making of proper joints. In no case will pipe be closer than four (4) inches from bed rock.
- M. In laying pipe, special care shall be taken to insure that each length shall abut against the next in such a manner that there shall be no shoulder or unevenness of any kind along the inside of the pipe line.
- N. No wedging or blocking will be permitted in laying pipe unless.
- O. Pipe and fittings shall be thoroughly cleaned before they are laid and shall be kept clean until the acceptance of the completed Work. The open end shall be kept closed with a stopper until the next length is laid. At the close of work each day, the end of the pipe line shall be tightly closed with an expansion stopper so that no dirt or other foreign substances may enter the line, and this stopper shall be kept in place until pipe laying is again resumed.
- P. Cold weather protection shall be provided, during freezing weather, for all masonry, mortar and concrete construction connected with the exterior piping by maintaining a temperature of not less than 50°F for a period of three (3) days, or by backfilling immediately, or by covering with backfill material in a temporary manner, all as directed by the Engineer.
- Q. All open ends of pipe lines to be abandoned, exposed during construction operations, shall have their openings plugged with a two (2) foot minimum thickness of concrete.

3.02 TESTING OF PRESSURE PIPES

- A. The Contractor shall furnish all labor, tools, materials, including water and equipment, including pumps, compressors, stopwatch, gauges and meters subject to the approval of the Engineer for testing in accordance with these specifications.
- B. The Engineer shall be notified in advance of all tests and all tests shall be conducted to his entire satisfaction.
- C. All pressure pipe shall be tested according to the latest revision of AWWA C600. Minimum test pressure shall be 100 psi.
- D. The water main and services shall be filled with water, supplied by the Contractor, and the pressure raised to obtain a minimum test pressure of 100 psi measured at the highest point of the section of pipeline under test. Particular care shall be taken to eliminate all air from the pipeline. The water main and services shall be subject to a leakage test at the specified test pressure, measured at the highest point of the section of pipeline under test. This test shall be a minimum of four (4) hours duration during which time the leakage shall not exceed 25 gallons per inch diameter per mile in 24 hours, and this is not to include any visible leaks. Should the test show the main and/or services to be defective, the Contractor shall remedy such defects and retest as specified above. This procedure shall be repeated until the test requirements are met.
- E. All leaks shall be repaired by the Contractor at no expense to the Owner. The Contractor shall make any and all repairs at his expense that may be necessary until the leakage test requirements have been met.
- F. Contractor shall test all pipe in the presence of the Engineer. All defects revealed by the tests, shall be corrected by the Contractor by replacement or repair of materials, as directed by the Engineer, at the Contractor's expense. After such replacement and/or repair, tests shall be repeated until all piping system are shown to be tight to the degrees specified. All labor, tools, materials, and equipment necessary for making these tests shall be adequately braced and supported during the test to prevent movement, displacement, or damage upon application of the test pressure. All equipment used in testing shall be subject to the approval of the Engineer.

3.03 BUTTRESSES AT FITTINGS

- A. Buttresses shall be installed on all underground pressure lines at all valves, bends, tees, and at reducers or other fittings where changes in direction or pipe size occur. The buttresses shall be as shown in the, City of Dover Public Utilities Department Standard Details and as shown on the drawings. Concrete shall bear against solid, undisturbed earth.

- B. Cold weather protection shall be provided, during freezing weather, for all masonry, mortar and concrete construction connected with the piping by maintaining a temperature of not less than 60 deg F. for a period of three (3) days.

3.04 DISINFECTION OF PIPING

- A. Disinfection of all water mains and services shall be in accordance with AWWA Standard C601, latest edition. A sufficient amount of Chlorine (HTH) tablets shall be placed in each length of pipe, hydrants, hydrant branches and other appurtenances, to insure adequate disinfection treatment of the main and services after their completion. Tablets shall be fastened to the inside top of every length of pipe as laid, using gasket cement known as "Permatex No. 2". Water for filling the mains and services shall be introduced at a velocity of less than 1 foot per second in order to permit the HTH or Perchloron to completely dissolve and have a reasonably uniform distribution throughout the pipe system. It is the intent of this specification to require a sufficient amount of chemical to be equivalent to a dosage of 50 p.p.m. of chlorine. After the chlorine has been in contact with the mains, services or storage units for twenty-four (24) hours or longer, samples collected from the extremities of the pipe system shall indicate a residual chlorine content of 5 p.p.m. or more. If less than 5 p.p.m. residual chlorine is indicated, the system shall be drained and the disinfection treatment repeated. If samples collected at the extremities indicate a residual chlorine of 5 p.p.m. or more, the system shall be drained or flushed to waste and then refilled.
- B. Water for disinfection shall be furnished by the Contractor from an approved source; the Contractor shall furnish and install all bulkheads, pipes, valves, taps, plugs, labor and other equipment required to sterilize the facilities. Water for filling the facilities should be introduced slowly and the quantity of chemical applied proportionately to the rate of water introduced.
- C. Water used for disinfection shall be disposed of in environmentally sound manner and to prevent damage to work of other sections.

3.05 SEWER (NON-PRESSURE) PIPE INSTALLATION

- A. No pipework is to be started until all materials, layout, schedules, stakeout, and cut sheets have been approved by the Engineer in writing. Samples of all materials to be incorporated in the Work shall be submitted for the approval of the Engineer sufficiently in advance of Work commencement to allow time for specified testing. Sewer pipe alignment shall be maintained through the use of laser alignment equipment. All installation shall follow the requirements of ASTM D2321.
- B. Proper and suitable tools and equipment for the safe and convenient handling and laying of the pipe and fittings shall be used in accordance with manufacturer's standards. Pipe and fittings shall be carefully handled and lowered into the trench.

- C. Whenever a pipe requires cutting to fit in the line or to bring it to the required location, the Work shall be done without extra compensation, in a satisfactory manner so as to leave a smooth end perpendicular to the axis of the pipe.
- D. Before any joints are actually made in the trench, the Contractor shall demonstrate to the Engineer, by making a sample joint, that the methods he will employ conform with specifications and will secure a watertight joint, and that the workmen whom he intends to use in this Work are familiar with the requirements.
- E. All laying, jointing, testing for defects and for leakage shall be performed in the presence of the Engineer. All defects in workmanship rejected by the Engineer shall be promptly corrected by the Contractor and defective material removed from the Project.
- F. The excavation in which pipe is being laid shall be kept free from water, and no joint shall be made under water. Care shall be used to secure water-tightness and to prevent damage to, or the disturbing of, the joints during the backfilling process or at any other time. After pipes have been laid and the joints have been made, there shall be no walking on or working over them except as may be necessary in tamping until there is a covering at least two (2) feet in depth over their top. After joint materials, which require it, have received their set, backfilling of the trench may proceed in the manner specified.
- G. Before joints are made, each pipe shall be well bedded on a solid foundation and no pipe shall be brought into position until the preceding length has been thoroughly embedded and secured in place. No pipe shall be laid in wet trench conditions that preclude proper bedding, or on a frozen trench bottom, or when in the opinion of the Engineer, the trench or weather conditions are unsuitable for proper installation. Any defects due to settlement shall be corrected by the Contractor at his own expense. Bell holes or coupling holes shall be dug sufficiently large to insure making of proper joints. In no case will pipe be closer than four (4) inches from bedrock.
- H. In laying pipe, special care shall be taken to insure that each length shall abut against the next in such a manner that there shall be no shoulder or unevenness of any kind along the inside of the pipe line.
- I. No wedging or blocking will be permitted in laying pipe unless by written order from the Engineer.
- J. Pipes and fittings shall be thoroughly cleaned before they are laid and shall be kept clean until the acceptance of the completed Work. The open end shall be kept closed with a stopper until the next length is laid. At the close of work each day, the end of the pipe line shall be tightly closed with an expansion stopper so that no dirt or other foreign substances may enter the line, and this stopper shall be kept in place until pipe laying is again resumed.
- K. Cold weather protection shall be provided, during freezing weather, for all masonry, mortar and concrete construction connected with the exterior piping by maintaining a

temperature of not less than 50°F for a period of three (3) days, or by backfilling immediately, or by covering with backfill material in a temporary manner, all as directed by the Engineer.

- L. All open ends of pipe lines to be abandoned, exposed during construction operations, shall have their openings plugged with a two (2) foot minimum thickness of concrete.
- M. All dead-ends of pipe lines, and fittings, shall be provided with standard plugs and caps either temporarily or permanently as directed by the Engineer. A concrete or other approved thrust blocking shall be provided at all dead ends. Where plugged or capped outlets are to be tied to fittings with clamps and tie rods, as indicated on the Contract Documents or as directed by the Engineer, the minimum number and size of rods and other pertinent details shall be as shown and/or specified.
- N. A metallic lined underground warning tape shall be placed over the entire length of all buried pipe. The tape shall be placed 24" above the pipe. The tape shall be 3", color green, with the message "Buried Sewer Line Below". Tape shall be equal to "Seton Nameplate Corporation" detection tape printed on polyethylene with a metallic core.
- O. Manholes shall be built as pipe laying progresses, and the Engineer may stop work entirely on laying pipe until the manhole just passed has been completed.

3.06 SEWER (NON-PRESSURE) PIPE TESTING

- A. The Contractor shall furnish all labor, tools, materials including water and equipment including mirrors, flashlights or other artificial lighting, weirs, pump, compressors, stopwatch, gauges, and meters, subject to the approval of the Engineer for testing in accordance with these specifications.
- B. Acceptance Pressure Test:
 - 1. All branch fittings and ends of lateral stubs shall be securely plugged to withstand internal test pressures. The section of line being tested shall also be securely plugged at each manhole. All stoppers shall be adequately braced when required.
 - 2. Air shall be slowly supplied to the plugged pipe line until the internal air pressure reaches 8.0 pounds per square inch. At least two minutes shall be allowed for temperature stabilization before proceeding further.
 - 3. The rate of air loss shall then be determined by measuring the time interval required for the internal pressure to decrease by 1.0 pound per square inch.
 - 4. The line shall be considered acceptable if the time, T, in seconds; required for the 1.0 psi pressure drop is not less than 10 minutes.
- C. Acceptance Visual Test:

1. A high powered light shall be placed at one end of the line in a manhole and the Contractor, in the presence of the Engineer, shall place a mirror at the next manhole to visually inspect the sewer for cleanliness and straightness.
2. Contractor shall provide a post-construction video within thirty (30) days of installation of sewer pipe, complete with inclination survey, utilizing Pipeline Assessment Certification Program (PACP) software.

3.08 PROTECTION OF INSTALLED WORK

- A. Protect installed pipe, joints, fittings and appurtenances from damage or displacement during the backfilling process or other construction activities.
- B. Keep pipe interior free from debris. Stopper open ends of pipe each day and until next length of pipe is laid.

3.09 ADJUSTING

- A. Adjust Work in accordance with Section 01700 and manufacturer's instructions.

END OF SECTION

SECTION 15005

SUPPORTS AND ANCHORS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Hangers, supports, brackets and anchors.

1.02 REFERENCES

- A. ANSI B31.1 Code for Pressure Piping
- B. MSS SP-58 Pipe Hangers and Supports - Materials, design and manufacturer.
- C. MSS SP-69 Pipe Hangers and Supports - Selection and application.

1.03 SUBMITTALS

- A. Submit under provisions of Section 01340.
- B. Product Data:
 - 1. Include data on materials, fittings and accessories.
 - 2. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
 - 3. Include dimension drawings indicating components and connections to structures, equipment and piping.
 - 4. Include product performance data.
- C. Manufacturer's Installation Instruction: Provide installation details and components assembly.

1.04 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01340 and 01700.
- B. Maintenance Data: Include maintenance and inspection data, replacement part numbers and availability.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with State and local regulations.
- B. Perform work in accordance with manufacturer's installation instructions.
- C. Selection, fabrication, and installation of pipe hangers and supports should conform to the latest requirements of:
 - 1. American National Standards Institute (ANSI) B31.1, Code for Pressure Piping.
 - 2. Manufacturers' Standardization Society (MSS) SP-58. Pipe Hangers and Supports-Materials, Design and Manufacture.
 - 3. Manufacturers' Standardization Society (MSS) SP-69, Pipe Hangers and Supports - Selection and Application.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. B-Line Systems, Inc.
509 West Monroe Street
Highland, Illinois 62249-0326
(618) 654-2184
- B. ITT Grinnell Corporation
Erie Avenue and D Street
Philadelphia, Pennsylvania 19134
(215) 425-5850
- C. Thunderline Corporation
8707 Samuel Barton Drive
Belleville, Michigan 48111
(313)397-5000
- D. UNISTRUT
16100 Lathrop Ave.
Harvey, IL 60426
(800)-882-5543

- E. Standon Pipe Supports, Inc.
2800 Taylor Way Bldg. 1
P.O. Box 247
Forest Grove, Oregon 97116

2.02 HANGERS

- A. Clevis hanger, stainless steel AISI Type 304, designed for suspending non-insulated stationary pipe allowing for vertical adjustment.

2.03 HANGER RODS

- A. Stainless steel AISI Type 304 rod with stainless steel nuts ASTM A194 GR F8.

2.04 FLOOR SUPPORTS

- A. Adjustable pipe saddle support with yoke, stainless steel AISI Type 304, designed for support of horizontal pipe from floor stanchions where vertical adjustment is required, with u-bolt and hex nuts to hold pipe securely to saddle, stainless steel AISI Type 304 and unthreaded square base plate stand with anchor holes, stainless steel AISI Type 304.

2.05 BRACKETS

- A. Stainless steel AISI Type 304 designed for supporting pipe from walls or structures where lateral adjustment is required.

2.06 RISER CLAMPS

- A. Heavy duty riser clamp stainless steel AISI Type 304, designed for supporting and stabilizing heavy-duty vertical pipe runs.

2.07 SUPPLEMENTAL STEEL

- A. Framing, racks consisting of channel, fittings, braces, brackets, associated hardware, stainless steel AISI Type 304.

2.08 PIPE SUPPORTS

- A. Pipe mounting support struts shall be fiberglass with SS hardware by UNISTRUT or equal.

2.09 THRUST BLOCKS

SUPPORTS AND ANCHORS

- A. Concrete, 4000 PSI.

PART 3 EXECUTION

3.01 INSTALLATION

- A. All pipe hangers and supports shall allow for the expansion and contraction of the piping system.
- B. The piping system shall have anchors, guides and supports so that the stress range is not excessive for the anticipated cycles of operation.
- C. Pipe hanger loads are to be determined by accurate weight balance calculations to prevent the transfer of loads to equipment or terminal connections.
- D. Support the piping system by using standard manufactured hangers and supports wherever possible.
- E. All pipe hangers and supports shall have 1-1/2 inch minimum adjustment available after installation.
- F. Hanger rods shall be subjected to tension only and must not exceed four-degrees of vertical angle. Lateral and axial movement shall be accommodated by proper linkage in the rod assembly.
- G. Horizontal piping with a centerline elevation of less than 4 feet shall be supported from the floor.
- H. Wall brackets shall be used to suspend or support pipe runs near a wall.
- I. Use pipe clamps where flexibility in the hanger assembly is required due to horizontal pipe movement. For non-insulated pipe, use standard pipe clamps.
- J. Vertical pipe runs shall be supported independently of any connected horizontal pipe. Use riser clamps to support the weight of the pipe.
- K. Supplemental steel shall be designed per AISC Steel Construction Manual and Local Building Codes.
- L. Coordinate placement of pipe support system with other work.
- M. Install pipe support system in accordance with manufacturer's instructions.

- N. Install pipe support system not to interfere with use of space or other work.
- O. Do not hang piping from other piping.
- P. Support underground piping per details on Drawings.
- Q. Provide thrust blocking for underground piping per details on accompanying drawings.
- R. Provide support at all concentrated loads such as valves, risers, etc.
- S. Place a hanger within 12 inches of each horizontal elbow.
- T. Design hangers to provide assembly without disengagement of supported pipe.

3.02 SUPPORT FOR PVC PIPING

- A. Support horizontal PVC piping using clevis or split ring type hangers. Provide at each location an 18 gauge stainless steel protective sleeve, minimum 6" long, to increase bearing area.
- B. At valves 2" and larger, provide additional support at valve location to reduce torque on piping run.
- C. Support PVC in accordance with the following schedule:
 - a. 1/4" - 3'O.C.
 - b. 1/2" to 3/4" - 4'O.C.
 - c. 1" - 4-1/2'O.C.
 - d. 1-1/4" to 2" - 5'O.C.
 - e. 2-1/2" to 4" - 6'O.C.

END OF SECTION

SECTION 15010

MECHANICAL GENERAL PROVISIONS

PART 1 GENERAL

1.01 NOTICE

- A. The requirements of Division 1, General Conditions, Supplementary Conditions, and Contract Drawings are hereby made a part of this section as fully as if repeated herein.
- B. The Contractor shall consult these sections in detail as he will be responsible for and governed by conditions set forth therein.

1.02 SUMMARY OF WORK

- A. This Section includes items related to the Mechanical Sections and the work required to be performed as indicated and specified in those Sections. The work shall be complete in all details including equipment with all appurtenances common to the various systems generally consisting of piping, ductwork, fittings, valves, dampers and supports, insulation, structure, cleaning, testing and such other material and work as is necessary, specified or required to form a complete and properly operating system as herein after specified or indicated.
- B. Temporary work specified herein shall apply to Mechanical Sections.
- C. The drawings accompanying these specifications are diagrammatic and intended to cover the approximate and relative locations of the HVAC and plumbing systems.

1.03 RELATED WORK

- A. Contractor shall direct his attention to other sections of the Specifications and Contract Documents for any related work, which may affect the work described under this Division.

1.04 MECHANICAL ABBREVIATIONS, REFERENCES & DEFINITIONS

- A. Abbreviations used herein and on the drawings are in accordance with ANSI Standard Y1.1.
- B. Reference should be made to the Contract Drawings for legends containing mechanical symbols used therein.
- C. References to technical societies, trade organizations and governmental agencies in the Mechanical Division are in accordance with the following:

1. ANSI: American National Standards Institute
2. ARI: Air Conditioning and Refrigeration Institute
3. ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers.
4. ASME: American Society of Mechanical Engineers
5. ASTM: American Society for Testing and Materials
6. FM: Factory Mutual System
7. NFPA: National Fire Protection Association
8. OSHA: Occupational Safety and Health Administration
9. SMACNA: Sheet Metal and Air Conditioning Contractors National Association.
10. UL: Underwriters' Laboratories, Inc.

D. The following definitions of terms and expressions are applicable to the Mechanical Division:

1. "Provide" shall mean "furnish and install".
2. "Herein" shall mean "contents of a particular Division" where the term appears.
3. "Indicated" shall mean "indicated on Contract Drawings".
4. "Contractor" shall mean "Contractor or Sub-contractor for the work described.
5. "Equal" shall mean "equivalent".
6. "Engineer" shall mean "Engineer or his authorized representative".
7. "Concealed" where used in connection with insulation and painting of piping, ducts and accessories, shall mean that they are hidden from sight as in trenches, chases, furred spaces, pipe shafts or hung ceilings, but not including tunnels.
8. "Exposed" where used in connection with insulation and painting of piping, ducts and accessories shall mean that they are not "concealed" as defined herein above.
9. "Piping" includes in addition to pipe, also fittings, valves, hangers, and other accessories, which comprise a system.

1.05 GOVERNING REQUIREMENTS

- A. Mechanical installation shall comply with all applicable codes, ordinances, rules, regulations and laws in effect. The construction of the systems indicated and called for in these Specifications shall be performed in accordance with standard industry practice and equipment manufacturers' specifications. The Contractor shall be responsible for obtaining the necessary information to comply with these requirements. Any modification of the Drawings or Specifications that may be necessary to meet these requirements must be approved by the Engineer before they are made.
- B. The Contractor shall give all notices and comply with all laws, ordinances, codes, rules and regulations bearing on the conduct of the work as drawn and specified. If the Contractor observes that the Drawings and/or Specifications are at variance therewith, he shall promptly notify the Engineer in writing of any necessary changes of work. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, codes, rules and regulations, and without such notice to the Engineer he shall bear all cost arising there from.
- C. Contractor shall obtain and pay for all necessary permits for work. Contractor shall arrange and pay for all tests and inspections specified herein or required by above agencies and furnish required certificates of inspection to Owner.
- D. Requirements of the following organizations shall be considered minimum:
 - 1. National Plumbing Code (where applicable)
 - 2. OSHA
 - 3. NFPA
 - 4. UL
 - 5. BOCA
 - 6. SMACNA
 - 7. FM
 - 8. IMC

1.06 GENERAL INSTALLATION REQUIREMENTS

- A. The contractors shall check all dimensions indicated. Advise the Engineer promptly of any discrepancies or interferences and obtain such measurements and information as may be required to satisfactorily install the work.

- B. Before ordering any material or doing any work, the Contractors shall verify all measurements and elevations at the building site and shall be responsible for the correctness of same. Any difference which may be found between field measurements and elevations and those indicated shall be promptly submitted to the Engineer for adjustment and approval before proceeding with the work.
- C. The Contractors shall lay out their work and establish heights and grades in strict accordance with the Drawings, the building and finished site grades, and shall be responsible for the accuracy of such layout.
- D. The Mechanical and Plumbing Contractors shall coordinate with all other trades before any piping, or ductwork is installed. All work shall be arranged so that piping and ductwork shall be kept as high as possible without interference.
- E. The arrangement of piping, ductwork, equipment and accessories shall be considered approximate except where dimensioned. The work shall be installed generally as indicated. Piping, ductwork and conduit shall be as straight and direct as possible, parallel to or at right angles to building walls and other lines where installed exposed and properly spaced. Piping shall be installed at uniform grade, supported on multiple hangers where practical and adjusted to drop required. All work shall be executed in a workman like manner and shall present a neat mechanical appearance when completed. The right is reserved by Owner to make any reasonable changes in location, prior to rough-in or setting, to accommodate conditions arising during progress of the work, without additional cost to the Owner.
- F. Align, level and adjust equipment for satisfactory operation: install so that connecting and disconnecting of piping and accessories can be done readily, and so that all parts are easily accessible for inspection, operation and maintenance.
- G. Material and equipment shall be installed in accordance with manufacturers' written instructions and recommendations. The mechanical contractor shall submit such data to the Owner prior to installation and it shall be considered a part of these Specifications.

1.07 MATERIALS & EQUIPMENT REQUIREMENTS

- A. Provide materials and equipment conforming to those specified herein, equivalent equipment of listed manufacturers will be considered.
- B. All material and equipment shall conform to capacity, efficiency; design and material specified and shall meet dimension and space requirements. Sizes of materials and equipment indicated or specified are minimum requirements. Contractor may, upon the Engineer's approval, use larger sizes to expedite the work, provided that such change meets space requirements and does not result in additional installation, maintenance or operating cost. Equipment or materials of

the same type of classification used for the same purpose shall be the products of the same manufacturer.

- C. All materials shall be new, of the best of their respective kind and shall conform to accepted standards of the trade in every case where such a standard has been established for the particular type of material.
- D. Equipment and accessories not specifically described or identified by manufacturer's catalog numbers shall be designed in conformity with applicable technical standards and specifications of societies, organizations and/or agencies listed herein, suitable for maximum working pressure and shall have a neat and finished appearance.
- E. Materials and appliances of types for which there are UL standard requirements, listings or labels; shall have such listing of UL, be so labeled, and shall conform to their requirements.
- F. In all cases where a device or part of the equipment is herein referred to in the singular number, it is intended that such reference shall apply to as many such items as are required to complete the installation.
- G. Contractor shall, without charge, replace any work or material, which develops defects, except ordinary wear and tear, or fails to perform satisfactorily, within one (1) year from the date of final acceptance.

1.08 SUBSTITUTIONS

- A. Manufacturer's names and catalog numbers for material and equipment are given to describe type, quality and design of material and equipment required. Where possible, three (3) or more manufacturers are listed.
- B. Where materials or makes are specified and where the words "or equal" is not used, only the makes specified shall be furnished and installed.
- C. Where "or equal" is used followed by manufacturer name(s), indicates manufacturers with acceptable deviations from the specified product which may require changes to the installation.
- D. In the event that an "or equal" manufacturer is used the contractor shall be responsible for any additional installation costs incurred as a result of the deviations in using the "or equal" product.

1.09 DESCRIPTIVE LITERATURE & SHOP DRAWINGS

- A. The Contractor shall secure descriptive drawings or catalog cuts of equipment and material to be furnished under his contract. He shall review these Shop Drawings for conformance to contract documents prior to submission for approval. No

equipment shall be ordered until the submissions have been approved by the Engineer.

B. Shop Drawings shall be identified in accordance with the following provisions:

1. Project Name and Location
2. Project Number
3. Date submitted
4. Vendor Name and Address
5. Clear identification of the specific model being submitted, size and other characteristics including options as specified.
6. Applicable contract drawings and specification section number.

1.10 SYSTEM OPERATING INSTRUCTIONS

A. Verbal Instructions

1. On completion of all tests and adjustments, Contractor shall instruct Owner in all details and operation of respective system(s).
2. When requested, supply attendants to operate the system(s) until the Owner is satisfied that the system(s) have been installed in accordance with these Drawings and Specifications and are functioning properly.
3. Provide services of equipment manufacturer's engineer to instruct the Owner in operation and maintenance of mechanical equipment and controls and to perform equipment start-up and adjustments, if requested.

B. Written Instructions

1. Provide three (3) copies of printed instructions, parts list and diagrams covering operating and maintenance of each item of equipment and controls.
2. Instructions, parts list and diagrams furnished in bound covers and delivered to the Owner.
3. Diagrams include performance curves for pumps, minimum size 8-1/2" x 11".

1.12 DAMAGE TO OTHER WORK

- A. The mechanical contractor shall be held responsible for all damage to other work caused by his work or through the neglect of his workmen or sub-contractors. All patching and repairing of damaged work shall be done by the contractor who installed the work, but the cost of same shall be paid for by the responsible contractor.

1.13 STARTING OF MECHANICAL SYSTEMS

- A. Bearings:
 - 1. Inspect for cleanliness. Clean and remove foreign materials.
 - 2. Verify alignment.
 - 3. Replace defective bearings, and those, which run rough or noisy.
- B. Motors:
 - 1. Check each motor for amperage comparison to nameplate value.
 - 2. Correct conditions which produce excessive current flow, and which exist due to equipment malfunction.
- C. Remove rust, scale and foreign materials from equipment and renew defaced surfaces.
- D. Inspect inside of ductwork for debris, etc. Clean inside of ductwork as required.

1.14 LAYOUTS

- A. Mechanical system layouts indicated are generally diagrammatic and location of services and equipment is approximate; exact routing of ductwork, piping, locations of services and equipment shall be governed by structural conditions and obstructions. This is not to be construed to permit redesigning systems; all services and equipment shall be interconnected as indicated. Locate and install equipment requiring maintenance and operation so that it will be readily accessible. Any relocation of services or equipment must be approved by the Engineer or authorized representative before erection. The right is reserved to make any reasonable change in location of services and equipment prior to "roughing-in" without involving additional cost.

1.15 PERMITS AND INSPECTIONS

- A. Permits and licenses necessary for the execution of this work shall be secured and paid for by the Contractor.
- B. Contractor shall arrange for all inspections specified herein or required by all agencies having jurisdiction and furnish required certificates of inspection to Owner, including electrical certificate from State licensed agency.

PART 2 PRODUCTS

Not Applicable

PART 3 EXECUTION

Not Applicable

END OF SECTION

SECTION 15050

BASIC MATERIALS AND METHODS

PART 1 GENERAL

1.01 NOTICE

- A. The requirements of Division 1, the General Conditions, the Supplementary General Conditions and the Contract Drawings are hereby made a part of this section as fully as if repeated herein.
- B. The Contractor shall consult these sections in detail as he will be responsible for and governed by the conditions set forth therein and the work indicated.
- C. The Contractor shall be responsible for coordinating with the local Natural Gas utility for gas service to the Headworks building. The Contractor shall complete all applications and coordinate the location for tie-in to their service and service pipe location to the building. Any charges by the utility for the service shall be borne by the Contractor.

1.02 DESCRIPTION

- A. Type: This Section specifies piping materials and installation methods and includes joining materials, piping specialties, and basic piping installation instructions. Piping materials and installation methods peculiar to individual systems are also specified.

Extent of work required by this section is indicated in drawings and by requirement of this section. The work includes domestic hot and cold water, sanitary piping, natural gas piping, etc.

1.03 SUBMITTALS

- A. Submit shop drawings and descriptive data in accordance with the General and Supplementary Conditions and Division 1 of this Specification.
- B. Obtain approval of submittals prior to ordering or fabricating materials.
- C. Furnish Shop Drawings and descriptive data, complete with required project designation, for the following:
 - 1. Valves (all types).
 - 2. Pressure relief valves
 - 3. Gauges and thermometers

PART 2 PRODUCTS

2.01 PIPE AND FITTINGS

- A. Copper pipe

1. Material:
 - a. Above Ground: Type "L" hard.
 - b. Refrigerant: ACR Type "L" hard.
2. Standards: ASTM B-280 (ACR), ASTM B-88
3. Fittings: Wrought copper, ASME B16.22; dielectric fittings between copper and steel pipe as manufactured by EPCO or equal.
4. Joint material: Alloy Grade 95-5 (95% tin - 5% silver) in wire or rod conforming to ASTM B-32 with flux as recommended by manufacturer applied to fitting and pipe; silver-solder shall be used underground and on all refrigerant piping. See service schedule for type required on each pipe service.

B. PVC Pipe

1. Material: Schedule 40, DWV or SDR class as indicated, white virgin material, Type 1, Grade 1, as indicated for respective service.
2. Standards: ASTM D-1785 for Schedule 40 PVC; ASTM D-2665 and NSF approved for DWV; ASTM D-3034 for SDR.
3. Fittings: PVC material, solvent weld, Type 1, ASTM D-2466 for Schedule 40, and ASTM D2665 for DWV; ASTM D-3212 for SDR.
4. Joint material: Use solvent cement in accordance with industry standards and manufacturer's recommendations.
5. Valves: 2" and smaller: Molded in place ball type valve with socket welded connection.

C. Steel Pipe

1. Standards: ANSI B125.2 / ASTM A-120
2. Weight: Schedule 40 or as indicated
3. Finish: Black or as indicated
4. Fittings: Screw Malleable iron, ANSI B16.3, 150 lb. black or galvanized as specified; cast iron, ANSI B16.12, galvanized drainage fittings, ANSI 16.4 pressure rated fittings.
5. Unions 2" and smaller: Screwed pattern, malleable iron, 125 lb. and galvanized or black finish matching pipe.
6. Non-hardening thread paste rated for natural gas.

7. Flanges: For pipe size 2-1/2-inch and more, provide 150 psi, raised face, weld neck type flanges. Material shall be same as that for piping and fittings. Remove raised face on flanges connecting to flat face valves or equipment.
8. Gaskets: Provide 1/16" thick ring type gaskets of compressed non-asbestos sheet to flanged connections. The manufacturer shall be Crane, Durabla, Klingerit, Garlock or equal.

2.02 VALVES

A. Ball Valves

1. 2" and smaller: MSS-SP-110, ASTM B584, class 150 all brass screwed or solder ends as required, two piece body and cap, TFE seats and seals. NIBCO T-585-70 type for threaded and Type S-585-70 for soldered ends.
2. 3 "and 2 ½ "and smaller: MSS-SP-110, ASTM B584, class 150 all brass screwed or solder ends as required, two piece body and cap, TFE seats and seals. NIBCO T-590 type for threaded and Type S-590 for soldered ends.
3. Manufacturers: NIBCO, Watts, Apollo or equal.

B. Check Valves

1. 2" and smaller: MSS-SP-80, type 4, class 150, ASTM B62, all bronze, renewable composition disc, horizontal swing type, screwed bonnet, threaded or soldered ends.
2. Manufacturers: NIBCO, Stockham, Apollo, Milwaukee or equal.

C. General Valve Construction

1. Valves of type that can be packed under pressure when wide open.
2. Designed for 125 psi wwp, 250°F operation.
3. Manufacturer's name and working pressure cast integral on valve body.
4. Sleeve end type for solder joints used on copper pipe.

D. Gas Shut-Off Valve

1. 2" and smaller: All bronze, two piece body, chrome plated ball, blowout proof stem, reinforced TFE seat, and threaded ends.
2. 2-1/2" and larger: Lubricated plug type, semi-steel body, single gland, wrench operated, flanged ends.
3. Standards: U.L. listed for use with gas.

4. Manufacturer: NIBCO T-585-70-UL, Watts or equal.

- E. Escutcheons: Provide chrome-plated, stamped steel, hinged, split-ring escutcheon with set screw at all pipe sleeves and pipe passing through walls, floors or ceilings in finished areas and to permit free expansion and contraction of piping. Inside diameter shall closely fit pipe outside diameter or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings. Where pipe sleeve extend above finished floor, provide a floor plate with a deep recess. For light colored ceilings, they shall be of sheet brass or steel with baked-white semi-gloss enamel. In unfinished areas, provide aluminum cover plates. Provide pipe escutcheons of Chicago Specialty Mfg. Co. or Sanitary-Dash Mfg. Co., Grinnell or equal.

2.03 PRESSURE RELIEF VALVES

- A. General: Pressure relief valve for use in liquid steam or gaseous fluid service.
- B. Construction: Cast iron, steel or stainless steel body and spring case with stainless steel internal parts and neoprene, Viton or stainless steel diaphragm. (Depending on service, use as recommended by Manufacturers).
- C. Operating Conditions: 5 to 200 psig pressure range and 450°F maximum temperature.
- D. Size and capacity to suit service location.
- E. Manufacturer: Fisher No. "98H", or equal.

2.04 PIPE & VALVE IDENTIFICATION

- A. Identify each valve in all systems with black, numbered and stamped 1-1/2" brass or aluminum tags fastened to valve by brass chain and "S" - hook.
- B. Piping Identification: Identify piping with Seton "Setmark", or equal, semi-rigid plastic, wraparound pipe markers with flow arrows and conforming to ANSI A13.1. Locate marker at each valve, changes in direction, where pipes pass thru barriers and every 25' of horizontal runs. Lettering and background colors shall be in accordance with the following:
1. DOMESTIC COLD WATER - Green
 2. DOMESTIC HOT WATER - Yellow
 3. CONDENSATE - Yellow
 4. NATURAL GAS - Yellow

2.05 GAUGES & THERMOMETERS

- A. Thermometers

1. Construction: 9" scale, red reading mercury type with brass separable socket pattern, 3/4" thread with 3-1/2" stem length, accurate to within 1% of scale range, adjustable angle hinge.
2. Manufacturers: Trerice, Weiss, Marsh, Weskler or equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.
- F. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE APPLICATIONS

- A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
 1. Shutoff Duty: Use ball valves.
- B. Install shutoff-duty valves at each branch connection to supply mains, at supply connections to each piece of equipment, and elsewhere as indicated.
- C. Install safety relief valves on hot water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Do not install valves on pipe discharge to floor. Comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.

3.03 PIPING INSTALLATION

- A. Piping Layout
 1. Run piping parallel with or at right angles to walls, except as otherwise indicated.

2. Pitch piping uniformly to drain.
3. Conceal piping in finished areas in walls, ceilings, floors, chases, etc.
4. Run exposed piping as close as possible to walls and ceilings.
5. Size and location of piping as indicated.
6. Final equipment connections as indicated are diagrammatic. Contractor shall be responsible for actual routing of piping in compliance with diagrammatic details and physical space requirements.
7. Provide sleeves for pipes passing through concrete and masonry walls, gypsum board partitions and concrete floor and roof slab.

B. Workmanship

1. Complete installation to present a neat and orderly appearance.
2. Keep inside of pipes and fittings free from dirt and debris.
3. Exposed piping to show no tool marks.
4. After cutting, ream pipes out to full bore.
5. Cut pipe accurately and install without springing or forcing.

C. Fittings

1. Install accessible unions adjacent to all equipment, control valves, regulators and at the final connection to each piece of equipment to facilitate removal or repair of the equipment. Install elsewhere as indicated on the drawings.
2. Install companion flanges at flanged valves and at all equipment having flanged connections.
2. Do not install joints or fitting over any motor, switchboard or any other electrical equipment.
3. Provide swing joints at mains and connections to risers; and provide swing joints, expansion loops and fittings as required for flexible piping system.
4. Where changes in pipe sizes occur, use only reducing fittings; box unions and reducing bushings are not acceptable.
6. Install electric unions or couplings and nipple fitting to connect piping material of dissimilar metals.

D. Supports

1. Support horizontal piping with malleable iron clevis or split ring type hangers with machine thread. Comply with MSS-SP-69 and MSS-SP-89.
 - a. Do not support piping from other piping.
 - b. Use multiple or trapeze hangers where several pipes are installed parallel.
 - c. Use roller chairs and stands fastened to trapeze channels where provision for expansion and contraction in piping is required.
 - d. Support pipes 6" and larger with single roll type hangers having two rods and adjustable sockets; provide protection saddles.
 - e. Supports for insulated pipe shall have galvanized steel insulation protection shields to fit the outside diameter of the insulation. Shields shall be provided by the pipe support manufacturer and selected based on support and pipe size and insulation thickness.
 - f. Provide dielectric hanger connector for copper pipe equal to EPCO Model No. 385.
2. Hangers for copper pipe up to 1-1/4" shall be 3/8" rod at 5'-0".
3. Hangers shall be attached to building structure with beam clamps.
4. Support vertical risers with finished ring clamps at approximately 8' from floor on each floor.
5. Support piping underground by concrete or brick piers.

E. Sleeves & Escutcheons

1. Provide sleeves cut flush with surface for each pipe passing through walls, floors, partitions and ceilings.
 - a. Install sleeves one pipe size larger than pipe encased, except allow for insulation.
 - b. Install sleeves 1" above finished floor in areas where water is present.
 - c. Caulk and seal between sleeves and pipes; passing through interior walls and floors.
 - d. Install sleeve and mechanical sleeve seal at service penetration through foundation wall for watertight installation.
2. Provide escutcheon plate in finished areas around pipes passing through walls, floors, partitions and ceilings.

F. Joints

1. Copper pipe joints

- a. Make pipe and fitting mechanically clean, bright and fluxed.
- b. Apply flux and solder as recommended by manufacturer of solder type fittings.

G. PVC Piping

1. Support horizontal PVC piping using clevis or split ring type hangers as described for steel pipe. Provide at each location an 18 gage steel protective sleeve, minimum 6" long, to increase bearing area.
2. At valves 2" and larger, provide additional support at valve location to reduce torque on piping run.
3. Provide transitions from PVC to other piping materials using threaded adaptors for piping 2-1/2" and smaller and flanged for piping 3" and larger.
4. Support PVC in accordance with the following schedule:
 - a. 1/2" to 3/4" - 4' O.C.
 - b. 1" - 4'-6" O.C.
 - c. 1-1/4" to 2" - 5' O.C.
 - d. 2-1/2" to 3" - 6' O.C.
 - e. 3-1/2" to 4" - 6'-6" O.C.
5. Anchors and guides: Provide anchor points and guides in piping runs as indicated. Use materials and methods as specified by the piping manufacturer.

H. Gas Piping

1. Remove cutting and threading burrs before assembling piping. Do not install defective piping or fittings; with threads chipped, stripped or damaged.
2. Anchor piping to ensure proper direction of expansion and contraction.
3. Do not install gas piping in concrete slab or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumb waiter or elevator shaft. This does not apply to accessible above-ceiling space.
4. Install a drip leg at points where condensate may collect, at the outlet of the gas meter, and in a location readily accessible to permit cleaning and emptying. Do not install drips where condensate is likely to freeze. Construct drips and sediment traps using a tee fitting with the bottom outlet plugged or capped. Use a minimum of 3 pipe diameters in length for the drip leg. Use same size pipe for drip leg as the connected pipe.

5. Locate groups of pipes parallel to each other, spaced to permit servicing of valves. Provide 1/64" per foot (0.125%) downward slope in flow direction. Horizontal lines shall slope upward to risers and from risers to equipment. Install Tee-fitting with bottom outlet plugged or capped at bottom of pipe risers.
6. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down. Connect branch outlet pipes from the top or sides of horizontal lines, not from the bottom.
7. Install a gas cock upstream and within 6 feet of gas appliance.

3.04 CUTTING AND PATCHING

- A. Respective Contractor shall install all hangers, supports and pipe sleeves in floors, walls, partitions, ceilings, masonry, concrete and roof slabs as required to permit their work to be built into place.
- B. All cutting of existing concrete, plaster masonry, or other material for the passage of piping through floors, walls, partitions and ceiling shall be done by the Contractor where necessary to perform his work. Respective Contractor will close all such openings around piping and conduit with material equivalent to that removed. All exposed surfaced shall be left in suitable condition for refinishing without further work.
- C. No structural member shall be altered or cut without the special permission of the Architect.
- D. Where piping passes through fire rated walls and floors, seal openings with fire resistant penetration seal compound use 3M CP25WB or equal.

3.05 PRESSURE TESTING

- A. Pressure test each piping system after installation, for 24 hours at 150% of operating pressure or at 25 psig, whichever is higher. Test fails, if pressure drop exceeds 5% of test pressure. Drain test water from piping system after testing and completion of repair work.
- B. Natural Gas Piping System
 1. Pressurize the system with air or nitrogen using procedures outlined in NFPA 54. If pressure loss is indicated, check all joints with a soapy water mixture. Vent off the system, repair the leaks, and repeat the test.
 2. All instruments, labor and facilities, including compressed air or nitrogen, required to properly conduct the tests shall be provided by the Contractor.
 3. See NFPA 54, "National Fuel Gas Code" for further requirements.

3.06 INSTALLATION OF VENTS AND DRAINS

- A. Provide drains at low points and vents at high points to all piping. The drains shall be valved and piped up to sewer. Vents shall be valved. Provide necessary drains, off-sets,

vents and drips for coordination of the work, as part of this contract. Do not install trapped lines where water can not be drained or air can accumulate without being vented.

3.08 PIPING MATERIAL/SERVICE SCHEDULE

SERVICE (SYMBOL)	MATERIAL FINISH	SIZE	JOINT CONST.	INSULATION REQUIRED	REMARKS
Domestic Cold Water (CW)	Copper Type "L"	All Sizes	Solder 95/5	Elastomeric Tubing	Note 2
Domestic Cold Water (CW)	CPVC Plastic	All Sizes	Solvent Welded	Elastomeric Tubing	Note 3
Domestic Hot Water (HW)	Copper Type "L"	All Sizes	Solder 95/5	Elastomeric Tubing	Note 2
Domestic Hot Water (HW)	CPVC Plastic	All Sizes	Solvent Welded	Elastomeric Tubing	Note 3
Domestic Hot Water (HWR)	CPVC Plastic	All Sizes	Solvent Welded	Elastomeric Tubing	Note 3
Condensate (C)	PVC SDR-21	All Sizes	Solder 95/5	Elastomeric Tubing	Note 1, 4
Natural Gas (G)	Black Steel SCH.40	All Sizes	Threaded	None	Note 5, 6

MATERIAL NOTES:

- 1: Refer to Supports/Anchors for special requirements.
- 2: Within building above grade.
- 3: Fluorosilicic Room only.
- 4: Insulate only within non-conditioned spaces.
- 5: For gas pressures of 5 psig or less.
- 6: Not for underground use.

END OF SECTION 15050

SECTION 15250

MECHANICAL INSULATION

PART 1 GENERAL

1.01 NOTICE

- A. The requirements of Division 1, the General Conditions, the Supplementary General Conditions and Contract Drawings are hereby made a part of this section as fully as if repeated herein.
- B. The Contractor shall consult these sections in detail as he will be responsible for and governed by the conditions set forth therein and the work indicated.

1.02 DESCRIPTION

- A. Perform all work necessary and/or required and furnish all materials for complete insulation of systems specified. Such work includes, but is not limited to domestic cold water, hot water and hot water recirculation piping.
- B. Refer to Contract Drawings for further extent of insulation work.

1.03 QUALITY ASSURANCE

- A. Standards: All insulation shall adhere to fire and smoke ratings as tested by procedures specified under ASTM E-84, UL 723 and NFPA 255. Flame Spread and Smoke Development ratings shall not exceed 25 and 50 respectively when tested in accordance with the above.
- B. Acceptable Manufacturers: Manufacturer's names and catalog numbers are used herein to describe type and quality of insulating materials desired. Products shall be as manufactured by "Armstrong" or equal.

1.04 SUBMITTALS

- A. Furnish shop drawings indicating type of insulation to be used and application method. Furnish samples as requested.
- B. Shop drawings shall be in accordance with the General Conditions of this Specification.
- C. Obtain approval of submittals prior to ordering or fabricating equipment of materials.

1.05 PRODUCT DELIVERY, HANDLING & STORAGE

- A. Delivery: Deliver all materials to project site in manufacturer's unopened original packaging.
- B. Handling: During loading, transporting and unloading exercise care to prevent damage to materials.

- C. Storage: Store materials in area protected from weather, moisture and mechanical damage.

PART 2 PRODUCTS

2.01 GENERAL

- A. Owens/Corning Fiberglass (Type I) and Armacell Engineered Foams flexible (Type II) as standard of design and construction. Manville, Certain-Teed, Knauf, or equal equivalents acceptable.
- B. Piping, fittings, valves, casing, housings and all other items shall be tested, approved, cleaned and dried before application of insulation. Insulation shall include all insulating materials, their application and finishes as required and in accordance with the manufacturer's instruction.
- C. All thermal and acoustic insulating materials, including the pipe insulation, jackets, facings and adhesives used to adhere jacket or facing to the insulation, including fittings and butt strips, shall have non-combustible fire and smoke hazard system rating and label as tested by ASTM E-84, NFPA 255 and UL 723, not exceeding flame spread 25, fuel contributed 50, smoke developed 50. Accessories such as adhesives, mastics, cement, tapes and caulk for fittings shall have the same ratings as listed above. All products and materials shall bear the UL label, and in addition, the vapor barrier jacket of each section of insulation shall be labeled indicating compliance with UL and complete product nomenclature.

2.02 PIPING INSULATION

- A. Unslit Elastomeric Tubing
 1. General: Flexible elastomeric closed cell foam, preformed, unslit thermal insulation supplied as tubing.
 2. Joints: Joints and seams shall be sealed with Armstrong 520 adhesive or as approved by the manufacturer.
 3. Finish: After installation in exposed areas, insulation shall be finished with two (2) coats of Lucite outside, white latex paint.
 4. Standards: ASTM C-534, Type I-tubular and ASTM D-1056, 2B1; flame spread of 25 or less and smoke developed rating of 50 or less when tested in accordance with ASTM E-84, latest revision.
 5. Applicability: Suitable for pipe systems operating from -40 F to +220 F.
 6. Thermal Conductivity: 0.27 BTU-IN/HR-S.F.- F at 75 F mean temperature.
 7. Surface Burning Characteristics:

- a. Flame Spread 25
 - b. Smoke Development 50
8. Wall Thickness
- a. Domestic Hot and cold water (all sizes): ½” thick.
 - b. Refrigerant suction lines: 1/2" thick.
9. Manufacturer: Armstrong Type “AP Armaflex” or equal.
10. Alternative: Contractor has option to use Armstrong self-seal "Armaflex SS" insulation (or approved equal). Self-sealing insulation and fittings to be applied as per manufacturers recommendations.

PART 3 EXECUTION

3.01 PIPING INSULATION INSTALLATION

A. Elastomeric Tubing

1. Location: Insulate all heat pump supply and return piping, domestic hot water, cold water and condensate drain lines, outdoor heat pump supply and return.
2. Surface: Clean surface to be insulated of all dirt, rust, oil, paint or scale.
3. Joints: Butt sections of insulation tightly together and seal with adhesive as recommended by the manufacturer.
4. Bends, fittings and valve bodies:
 - a. Fitting covers shall be fabricated using miter-cut sections of tubular form of the insulation.
 - b. All fitting covers shall be adhered using the same seal type adhesive used for butt seams.
5. After insulation is in place and secured with adhesive apply a waterproof coating over entire surface where exposed to the weather. Use products as specified herein and as recommended by the insulation manufacturer.
6. Consult manufacturer's installation instructions for further details.

3.02 GENERAL PIPING INSULATION INSTALLATION

- A. General: Install insulation products per manufacturer's written instructions and per recognized industry practice to ensure that insulation serves its purpose. Do not apply insulation to equipment while hot.

1. Install insulation only after the piping has been pressure tested and approved tight by inspector and after which the piping has been drained, thoroughly cleaned from outside and painted with suitable primer. Install insulation on mechanical systems subsequent to testing and acceptance of tests.
2. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
3. Clean and dry surfaces prior to insulating. Butt insulating joints firmly together to ensure complete and tight fit over surfaces to be covered.
4. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damages.
5. Extend insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.
6. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2". Apply over vapor barrier where applicable.

END OF SECTION 15250

SECTION 15400

PLUMBING SYSTEMS

PART 1 - GENERAL

1.01 NOTICE

- A. The requirements of Division 1, the General Conditions, the Supplementary General Conditions and the Contract Drawings are hereby made a part of this section as fully as if repeated herein.
- B. The Contractor shall consult these sections in detail as he will be responsible for and governed by the conditions set forth therein and the work indicated.

1.02 DESCRIPTION

- A. Description of System(s): Perform all work necessary and/or required and furnish all materials for a complete installation of the system(s) indicated and specified. Such work shall include, but not be limited to, the following:
 - 1. Domestic cold water system piping.
 - 2. Domestic hot water system piping.
 - 3. Tepid Water System
 - 4. All miscellaneous devices and accessories for the domestic and sanitary systems.

1.03 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Unless otherwise specified or indicated, all materials and equipment shall be the products of a manufacturer regularly engaged in the production of plumbing materials and equipment.
 - 2. All design, fabrication and erection shall be performed in full compliance with all applicable laws, ordinances, rules, regulations and the latest edition of the following codes and standards:
 - a. BOCA
 - b. National Plumbing Code
 - c. NFPA
 - d. UL
 - e. OSHA
- B. Requirements of Regulatory Agencies:
 - 1. Contractor shall comply with all applicable code and regulatory requirements of Federal, State and local authorities. These shall include, but not be limited to, the following:

- a. State Health Department
 - b. Local Department of Licenses and Inspections
2. Contractor shall comply with all requirements regarding the testing and inspections of domestic water and sanitary piping systems.

1.04 SUBMITTALS

A. General:

1. Submit shop drawings and descriptive data in accordance with the General and Supplementary Conditions of this Specification.
2. Obtain approval of submittals prior to ordering or fabricating materials.

B. Shop Drawings: Furnish shop drawings and descriptive data, complete with project designation, for the following

1. Gas Water Heater
2. Domestic Water Recirculation Pump
3. Thermostatic Mixing Valve
4. Expansion Tank

1.05 PRODUCT DELIVERY, HANDLING & STORAGE

- A. Delivery: Deliver equipment and materials to project site in manufacturer's unopened original packaging.
- B. Handling: During loading, transporting and unloading exercise care to prevent damage to equipment and materials.
- C. Storage: Store materials in area protected from weather, moisture and mechanical damage. Materials that have been exposed to weather or moisture and exhibit excessive scale, rust or water damage will not be permitted.

PART 2 - PRODUCTS

2.01 GAS HOT WATER HEATER (WH)

- A. Type: Vertical propane gas fired hot water heater, certified, labeled and listed by the AGA.
- B. Construction: "Bowdlerized" steel housing finished in baked on enamel, glass or stone lined and insulated with fiberglass blanket type insulation. Clean-out access for removal of sediment.
- C. Fittings and Accessories:
1. ASME approved temperature and pressure relief valve.
 2. Magnesium anode rods for corrosion control.
 3. Electronic ignition

4. Drain valve with hose connection.
5. Inlet and outlet fittings.
6. High limit energy cutoff with manual reset.
7. Power ventilating attachment.
8. Automatic gas shut-off on gas pilot failure.

D. Capacity: Consult Contract Drawings for listed schedule of capacity, recovery rate, etc.

E. Manufacturers: Bradford White or equal.

2.02 DOMESTIC HOT WATER RECIRCULATING PUMP (DP)

A. Centrifugal, in-line, oil lubricated, bronze body non-ferrous, recirculating pump with hardened stainless steel shaft and thrust collar supported by carbon sleeve bearings.

B. Motor shall be open, drip-proof, sleeve-bearing construction with built-in thermal overload protection.

C. Motor shall be non-loading at any point on the pump performance curve.

D. Capacity: Consult Contract Drawings for listed capacity.

E. Manufacturer: Bell and Gossett, Taco, Aurora.

2.03 THERMOSTATIC MIXING VALVE (TM-1)

A. Automatic hot water tempering valve constructed of brass and tested to 300 psi. Valve shall be adjustable to deliver water within close tolerance of any temperature.

B. Manufacturer: Holby Valve Company, Heat-Timer, Leonard.

2.04 EXPANSION TANK (ET)

A. General: Vertically suspended design for control of system pressure and hot potable water expansion.

B. Construction: Welded steel tank with flexible diaphragm, pre-pressurized air chamber. Maximum operating conditions 100 psig at 200EF.

C. Size and Capacity: Refer to contract drawings.

D. Manufacturer: John Wood, Taco, State, Bell & Gossett, Wessels.

PART 3 - EXECUTION

3.01 PIPING INSTALLATION

A. Domestic Water Piping Installation:

1. Cold water piping:
 - a. Layout: Connect at existing pipe inside building and install as indicated to water heater, wall supplies, plumbing fixtures, equipment, etc.
2. Hot water piping:
 - a. Layout: Install hot water piping, as indicated, from water heater to plumbing fixtures, equipment, etc.
3. Water piping accessories:
 - a. Install gate or ball valves in all branches leading from mains to groups of fixtures and as indicated.
 - b. Provide pneumatic air chambers (shock absorbers), of the size and type required for respective number of fixture units being served, at ends of horizontal runs serving groups of fixtures.

3.02 FLUSHING AND STERILIZING WATER SYSTEM

A. Flushing:

1. After water system has been tested and connected, open outlet nearest to new water service connection and let run until water is clear.
2. Repeat this process with each outlet working toward the furthestmost outlet from new water system connection.

B. Sterilization:

1. Introduce chlorine or solution of calcium or sodium hypochlorite, filling lines slowly and applying sterilizing agent at a rate of 50 ppm of chlorine as determined by residual chlorine tests at end of lines.
2. After sterilizing agent has been applied for 24 hours, test for residual chlorine at ends of lines; if less than 5 ppm, repeat process.
3. When test shows at least 5 ppm of residual chlorine, flush out system until all traces of chemicals used are removed.
4. If system is found bacteriological unsafe at any time prior to final acceptance, re-chlorinate as specified above.
5. Vendor: Waterchem

3.03 TESTING, BALANCING AND ADJUSTING

A. Test procedures outlined here are a minimum requirement. If requirements of governing authorities or utility companies are more stringent, perform testing procedures as directed thereby. Remove or valve any appurtenances that are not capable of withstanding test pressure.

B. Pressure testing of all piping systems as follows:

1. Entire system of exterior sanitary drainage and storm drainage piping and interior systems of soil, waste, vent.

- a. Test with water unless weather conditions prevent so doing, in which case, use air.
 - b. 10'-0" minimum static head of water or 5 psig minimum air pressure must be maintained for 60 minutes without loss of pressure.
 - c. Test separately and prove tight before backfilling, entire system of underground piping between sewer connection and vertical penetration of building or grade.
 - d. All portions of interior piping may be tested in sections with necessary test tee connection.
 - e. Finally, test entire system from sewer connection to remotest and/or highest fixture.
2. All systems of domestic water piping in place for a 24-hour period as follows:
- a. To 125 psig or 50 psig in excess of expected normal operating pressure, whichever is greater.
 - b. Maximum pressure drop of 1% of test pressure.
- C. Test, calibrate and adjust as required the following system components:
1. Relief valves
 2. Control sequence for domestic hot water systems
- D. On the entire domestic cold and hot water piping systems:
1. Balance to assure proper flow to each unit.
 2. Adjust as required for quiet and proper operation.

END OF SECTION

SECTION 15450

PLUMBING FIXTURES AND TRIM

PART 1 GENERAL

1.01 NOTICE

- A. The requirements of Division 1, the General Conditions, the Supplementary General Conditions and the Contract Drawings are hereby made a part of this section as fully as if repeated herein.
- B. The Contractor shall consult these sections in detail as he will be responsible for and governed by the conditions set forth therein and the work indicated.

1.02 DESCRIPTION

- A. Description of System(s): Perform all work necessary and/or required and furnish all materials for a complete installation of the system(s) indicated and specified. Such work shall include, but not be limited to, the following:
 - 1. Provide all plumbing fixtures, fittings, trim and accessories as indicated, specified and required. Make all rough-in and final connections to plumbing fixtures and devices.

1.03 QUALITY ASSURANCE

- A. Acceptable Manufacturers: Unless otherwise specified or indicated, all materials and equipment shall be the products of a manufacturer regularly engaged in the production of plumbing fixtures.
- B. Requirements of regulatory agencies: All design, fabrication and erection shall be performed in full compliance with all applicable laws, ordinances, rules, regulations and the latest edition of the following codes and standards:
 - 1. BOCA
 - 2. National Plumbing Code
 - 3. NFPA
 - 4. UL
 - 5. OSHA

1.04 SUBMITTALS

- A. Furnish shop drawing and descriptive data, complete with project designation, for the Safety Shower/Eye Wash with mixing valve.
- B. Obtain approval of submittals prior to ordering or fabricating materials.

1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

- A. Delivery: Deliver equipment and materials to project site in manufacturer's unopened original packaging.
- B. Handling: During loading, transporting and unloading exercise care to prevent damage to equipment and materials.
- C. Storage: Store materials in area protected from weather, moisture and mechanical damage. Materials that have been exposed to weather or moisture and exhibit excessive scale and rust will not be permitted.

1.06 GUARANTEE

- A. The Contractor shall, without charge, replace any work or material, which develops defects, except ordinary wear and tear, or fails to perform satisfactorily, within one (1) year from the date of final acceptance.

PART 2 PRODUCTS

2.01 SAFETY SHOWER/EYE WASH STATION (EEW/SS)

- A. Floor mounted, 1-1/4" IPS PVC piping with PVC fittings, 8" ABS plastic shower head in safety yellow with impeller face plate and 20 GPM flow rate, eye/face wash ABS plastic spray outlets, flip-top dust caps and stainless steel push handle, 3.8 GPM flow with optional flow switch. Manufacturer: Speakman Model No. SE-690-PVC or equal.
- B. TM-1 – Bronze body, temperature adjustable, dial thermometer liquid filled 4" face, minimum inlet temperature 120°F. (2) inlet and (1) outlet ports, 25 gpm capacity, Speakman Model No. SE-362 or equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. During wall construction, install fixture carriers as indicated and specified. The carrier frame shall be bolted to the floor slab with a minimum of four (4) bolts.

- B. Make adjustments to the carriers for required mounting height of fixture types.
- C. Install all carriers, fixtures and other devices in accordance with the manufacturer's "roughing in" dimensions.
- D. Insure that connections between waste piping and plumbing fixtures are made absolutely water tight.
- E. Make all water connections to plumbing fixtures using fittings specified. All exposed brass shall be chrome plated, unless indicated otherwise.
- F. Protect all fixtures, fittings and other devices from damage during the work.
- G. Fixture mounting heights shall be in accordance with applicable ANSI Standards.

3.02 ADJUST AND CLEAN

- A. Adjust all fixtures and fittings for proper operation and flow rates.
- B. Leave work area clean and free of all dirt, debris, etc.

END OF SECTION

SECTION 15800

AIR DISTRIBUTION

PART 1 - GENERAL

1.01 NOTICE

- A. The requirements of Division 1, the General Conditions, the Supplementary General Conditions and the Contract Drawings are hereby made a part of this section as fully as if repeated herein.
- B. The Contractor shall consult these sections in detail as he will be responsible for and governed by the conditions set forth therein and the work indicated.
- C. Product descriptions listed herein contain the characteristics of a general series or model. Contractor shall direct his attention to the Contract Drawings for specific sizes or capacities listed in equipment schedules contained herein.

1.02 DESCRIPTION

- A. Description of System(s): Perform all work necessary and/or required and furnish all materials for a complete installation of the system(s) indicated and specified. Such work shall include, but not be limited to, the following:
 - 1. Provide wall, roof and FRP fans.
 - 2. Provide wall louvers and motor operated dampers.
 - 3. Provide wall mounted dehumidifiers
 - 4. Provide PVC pipe duct.
 - 5. Provide FRP duct in Acid Room.

1.03 QUALITY ASSURANCE

- A. Acceptable Manufacturers: Unless otherwise specified or indicated, all materials and equipment shall be the products of a manufacturer regularly engaged in the production of air distribution devices.
- B. All design, fabrication and erection shall be performed in full compliance with all applicable laws, ordinances, rules, regulations and the latest edition of the following codes and standards:
 - 1. IMC
 - 2. ASHRAE
 - 3. SMACNA
 - 4. UL
 - 5. NFPA

1.04 SUBMITTALS

- A. Furnish shop drawings and descriptive data, complete with project designation, for the following:
 - 1. Panel wall Propeller Fans

2. Motor Operated Dampers
3. Louvers and Screens
4. Rain Hood and wall cap
5. Dehumidifiers
- 6 FRP Duct
7. FRP Centrifugal Fans
8. Shutter Damper

B. Shop drawings shall be in accordance with the General and Supplementary Conditions of this Specification.

C. Obtain approval of submittals prior to ordering or fabricating materials.

1.05 PRODUCT DELIVERY, HANDLING & STORAGE

A. Delivery: Deliver materials to project site in manufacturer's unopened original packaging.

B. Handling: During loading, transporting and unloading exercise care to prevent damage to materials.

C. Storage: Store materials in area protected from weather, moisture and mechanical damage

1.06 AIR SYSTEM TESTING & BALANCING

A. Contractor shall procure the services of an independent balancing and testing firm approved by the Engineer. The agency selected shall abide by the procedures set forth by the Associated Air Balance Council.

B. The contractor shall submit six (6) copies of a complete report, on a form approved by the AABC, signed and sealed by a registered engineer, and stating that all supply, return and exhaust systems have been balanced to specified air flows as follows:

1. Test and adjust fan rpm to design requirements.
2. Test and record motor full load amperes.
3. Test and record system static pressures, suction and discharge.
4. Test and adjust system for design cfm of recirculated air, where applicable.
5. Test and adjust system for design cfm of outside air.
6. Test and adjust each exhaust inlet to within 5% of design requirements.
7. In cooperation with the control manufacturer's representative, set adjustments of automatically operated dampers to operate as indicated or specified.

PART 2 - PRODUCTS

2.01 FIBERGLASS SHUTTER

A. SHUTTER (SD-23).

1. Shutter 4" deep with end-pivoted automatic shutter.
2. Fabricate of .070" thick fiberglass reinforced polyester with 1/8" fiberglass reinforced polyester angle.
3. Finish in factory standard color.
4. Manufacturer: Hartzell Fan Inc. model FEP, MK Plastics.

2.02 CENTRIFUGAL FIBERGLASS FANS (EF-23, EF-24)

- A. Fan shall be constructed of fiberglass reinforced plastic, aerodynamically designed with high efficiency inlet. The casing exterior shall be smooth and resin rich interior.
- B. Fastening bolts holding the casing to the support plate are to be encapsulated in FRP.
- C. Fans are to be supplied with a graphite liner and grounding strap to remove static electricity, as well as a flame redundancy of 25 or less.
- D. Fan impeller shall be solid molded FRP with radial tip curved blades. FRP hub shall have a tight fitting to protect the shaft end. The impeller shall be statically and dynamically balanced per AMCA 204 standard.
- E. Motors to be TEFC with 1.15 service factor.
- F. Manufacturer: Greenheck or approved equal.

2.03 VOLUME CONTROL DAMPER

- A. Fabricate in accordance with SMACNA Duct Construction Standard, latest addition.
- B. Fabricate frame of extruded aluminum channel with corner brace.
- C. Fabricate blades of 8 inches maximum width of extruded aluminum.
- D. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12 x 72 inches. Assemble center and edge crimped blades in prime coated frame with suitable hardware.
- E. Provide locking, indicating Quadrant Regulators on single and multi-blade dampers. Where rod lengths exceed 30 inches provide regulator at both ends.
- F. On insulated ducts mount Quadrant Regulators on stand off mounting brackets, bases or adapters.
- G. Sizes: Shown on drawings.

2.04 MOTOR OPERATED DAMPERS

- A. Construction: Dampers shall be constructed of minimum 16 gauge steel with maximum blade width of 8". Bearings shall be self-lubricating type. Blades shall have interlocking edges and shall be provided with blade seals. All multi blade two-position dampers shall

be parallel blade type. Control contractor shall furnish and install motors of adequate capacities to operate dampers described and where shown on contract drawings.

- B. Normal Application: Leakage rate shall be less than 14cfm/sq.ft. at 4" W.G.
- C. 120 volt cast aluminum actuator: power closed, spring open.
- D. Size: Consult contract drawings for damper location and size.
- E. Manufacturers: Penn Ventilation model "PCD20S", Ruskin, Greenheck, Cesco or equal.

2.05 LOUVERS

- A. Louvers 4" deep with 45° drainable blades, birdscreen with 3/4" square mesh for intake. Mount birdscreen on the inside face of blades.
- B. Fabricate of .125" thick extruded aluminum.
- C. Finish in factory color anodized finish. Color to be selected by Architect.
- D. Manufacturers: Green Heck Model ESD-403, Ruskin, Arrow, Louvers & Dampers, Inc. or equal.

2.06 WALL PANEL FANS (EF-21, EF-22)

- A. General: factory assembled wall mounted, direct driven, steel propeller fan, including housing, wheel and damper.
- B. Standards: rated in accordance with AMCA standards and bear the AMCA certified rating seal.
- C. Construction: the fan shall be bolted and welded construction utilizing corrosion resistant fasteners. The motor, bearings, and drives shall be mounted on a tubular steel power assembly minimum 14 gauge wall panel with continuously welded corners.
- D. Motor: heavy duty with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase and enclosure.
- E. Bearings: heavy duty regreasable ball type in cast iron pillow block housing for a minimum 150 life in excess of 200,000 hours.
- F. Accessories:
 - 1. Wall sleeve
 - 2. Motor guard
 - 3. Gravity shutter
 - 4. Rain Hood
- G. Manufacturer: Green Heck, Cook, Penn vent, Continental Air or equal.

2.07 FAN MOTORS AND DRIVE.

- A. Motors to be premium efficiency, standard NEMA frame, Direct Drive, TEFC with a 1.15 service factor.
- B. Drives up to 5 HP shall be provided with variable pitch sheave.
- C. Shaft to be ANSI C-1045 steel, and be protected with TECTYL 822B protective coating.
- D. Shafts to be AISI -1045 carbon steel. The shaft shall not be in the corrosive air stream.

PART 3 - EXECUTION

3.01 GENERAL EQUIPMENT INSTALLATION

- A. Except as indicated on Contract Drawings, all equipment shall be installed in accordance with the manufacturer's recommended installation procedures.

END OF SECTION

SECTION 16010

ELECTRICAL GENERAL PROVISIONS

PART 1 GENERAL

1.01 NOTICE

The General Conditions, Special Conditions, General Requirements, and Drawings are hereby made a part of this Section as fully as if repeated herein. Contractor shall consult these sections in detail as he will be responsible for and governed by conditions set forth therein and work indicated.

1.02 SCOPE OF WORK

- A. This division of the specifications covers the electrical systems of the project. It includes work performed by the electrical trades as well as trades not normally considered as electrical trades.
- B. Provide all incidentals, equipment, appliances, services, hoisting, scaffolding, supports, tools, supervision, labor consumable items, fees, licenses, etc., necessary to provide complete systems. Perform start-up and checkout on each item and system to provide fully operable systems.
- C. Examine and compare the Electrical Drawings with these specifications, and report any discrepancies between them to the Engineer and obtain from him written instructions for changes necessary in the work. At time of bid the most stringent requirements must be included in the bid.
- D. Examine and compare the Electrical Drawings and Specifications with the Drawings and Specifications of other trades, and report any discrepancies between them to the Engineer and obtain from him written instructions for changes necessary in the work. At time of bid, the most stringent requirements must be included in said bid.
- E. Install and coordinate the electrical work in cooperation with other trades installing interrelated work. Before installation, make proper provisions to avoid interferences in a manner approved by the Engineer. All changes required in the work of the Contractor, caused by his neglect to do so, shall be made by him at his own expense.
- F. It is the intent of the Drawings and Specifications to provide a complete workable system ready for the Owner's operation. Any item not specifically shown on the Drawings or called for in the Specifications, but normally required to conform to the intent, are to be considered a part of the Contract.

1.03 JOB CONDITIONS

The Contractor shall visit the site and familiarize himself with all existing and limiting conditions that have a bearing on his work. Failure to do so will not relieve him of any subsequent responsibilities pertinent to this project.

1.04 COORDINATION OF WORK

- A. The Contractor shall contact the electric utility company to make arrangements for all temporary and permanent service connections, and verify the location of all overhead and underground services.
- B. The Contractor shall order the progress of his work to conform to the progress of the work of the utilities and other trades, and shall complete the entire installation as soon as conditions permit. Any cost resulting from defective or ill-timed work performed under this section shall be borne by the Contractor.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Ship and store all products and materials in a manner that will protect them from damage, weather, and entry of debris. If items are damaged, do not install, but take immediate steps to obtain replacement or repair. Any such repairs shall be subject to review and acceptance of the Engineer.
- B. Deliver materials in manufacturer's unopened container, fully identified with manufacturer's name, trade name, type, class, grade, size and color.
- C. Store materials suitably sheltered from the elements, but readily accessible for inspection by the Engineer until installed. Store all items subject to moisture damage in dry, heated spaces.

1.06 PERMITS AND INSPECTIONS

- A. Permits and licenses necessary for the execution of this work shall be secured and paid for by the Contractor.
- B. Contractor shall arrange for all inspections specified herein, or as required by all agencies having jurisdiction. Furnish required certificates of inspection to the Owner, including an electrical certificate from a State licensed electrical inspection agency.

1.07 CODES AND STANDARDS

- A. All equipment, fixtures, and materials shall be equal to or exceed the minimum requirements of NEMA, IEEE, and UL.
- B. The installations shall conform to all applicable national, state and local codes, standards, ordinances, and regulations. The construction of the systems indicated and called for in these specifications shall be performed in accordance with such practices, except as otherwise indicated or specified. The Contractor shall be

responsible for obtaining the necessary information to comply with these requirements. Any modification of the drawings or specifications that may be necessary to meet these requirements must be approved by the Engineer or authorized representative before they are made.

- C. The Contractor shall give all notices and comply with all laws, ordinances, codes, rules and regulations bearing on the conduct of the work as drawn and specified. If the Contractor observes that the drawings and/or specifications are at variance therewith, he shall promptly notify the Engineer in writing of any necessary changes of work. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, codes, rules and regulations and such notice to the Engineer, he shall bear all costs arising from same.
- D. Most-current requirements of the following organizations, codes, and standards shall be considered minimum:
 - 1. National Electrical Code (NFPA 70)
 - 2. Standard for Electrical Safety in the Workplace (NFPA 70E)
 - 3. National Electrical Safety Code
 - 4. Life Safety Code
 - 5. Local Utility Company
 - 6. Occupational Safety and Health Administration (OSHA)
 - 7. Local, city, and county codes

1.08 ELECTRICAL ABBREVIATIONS, REFERENCES AND DEFINITIONS

- A. Abbreviations and symbols herein and on Drawings are in accordance with ANSI standards.
- B. References to technical societies, trade organizations and governmental agencies in the Electrical Division are in accordance with the following:
 - 1. ANSI - American National Standards Institute
 - 2. ASTM - American Society for Testing Materials
 - 3. IEEE - Institute of Electrical and Electronics Engineers, Inc.
 - 4. NEC - National Electrical Code
 - 5. NEMA - National Electrical Manufacturers Association

6. NFPA - National Fire Protection Association
 7. OSHA - Occupational Safety and Health Administration
 8. UL - Underwriters' Laboratories, Inc.
- C. The following definitions of terms and expressions are applicable to the Electrical Division.
1. "Provide" shall mean "furnish and install."
 2. "Herein" shall mean "contents of a particular Division" where this term appears.
 3. "Indicated" shall mean "indicated on Contract Drawings."
 4. "Equal" shall mean "approved equivalent."
 5. "Contractor" shall mean "Contractor or subcontractor for work described."

1.09 TESTS

- A. Arrange and pay for all tests. Notify Engineer three (3) working days before tests are made. Conduct tests in presence of Engineer or authorized representative. Repeat tests after defects are corrected.
- B. Prior to tests, provide feeders and branch circuits continuous from main distribution panel to outlets, fixtures, and equipment.
1. Demonstrate system is free from short circuits and properly grounded.
 2. Test lighting circuits for correct operation after lamps are installed.
 3. Check all motors for correct rotation.
 4. Test load balance as specified herein.

1.10 SYSTEM OPERATION INSTRUCTIONS

- A. Verbal Instruction
1. After all tests and adjustments, Contractor shall instruct attendant or Owner's representative in all details of operation of distribution system.
 2. Supply operators to operate the systems until Engineer is satisfied that the systems have been installed in accordance with these Drawings and Specifications and are functioning properly.

3. Provide services and equipment manufacturer's engineer to instruct representative of Owner in operation and maintenance of electrical equipment.

B. Written Instruction

1. Provide two (2) copies of printed instructions and diagrams covering operation and maintenance of each item of equipment.
2. Instructions furnished in bound covers and posted at locations designated by Engineer or authorized representative.

1.11 LAYOUTS

- A. Electrical system layouts indicated are generally diagrammatic and location of outlets and equipment is approximate. Exact routing of raceways, locations of outlets and equipment shall be governed by structural conditions and obstructions. The Contractor shall be responsible for the final layout of all equipment. This is not to be construed to permit redesigning systems. All outlets and equipment shall be interconnected as indicated. Locate and install equipment requiring maintenance and operation so that it will be readily accessible. Any relocation of outlets or equipment must be approved by the Engineer or authorized representative before installation. The right is reserved to make any reasonable change in location of outlets and equipment prior to "roughing-in" without involving additional cost.
- B. Coordinate the installation of wiring, raceways, outlet boxes, sleeves, anchors, and other concealed or embedded items so that this work is properly in place before concrete or partitions are in place.

1.12 SUBMITTALS

- A. The Contractor shall submit a list of materials required for the project within thirty (30) days after the award of the contract. This list shall be complete and include all items or systems called for in this contract. Partial lists submitted from time to time will not be acceptable. The list shall identify the specific item, manufacturer, and vendor. Vendor information only will not be acceptable.
- B. After approval of the material list, the Contractor shall secure descriptive drawings or catalog cuts of equipment to be furnished under his contract. He shall review these Shop Drawings for conformance to contract documents prior to submission for approval. No equipment shall be ordered until it has been approved.
- C. Shop Drawings shall be in accordance with General Conditions and Supplementary General Conditions of these Specifications.
- D. All Shop Drawing submittals shall have the following identification data, as applicable, contained therein or permanently adhered thereto.

1. Project name
2. Project number
3. Subcontractor's, Vendor's, and/or Manufacturer's name and address
4. Product identification
5. Applicable contract drawings and specifications section number
6. Shop Drawing title, drawing number, revision number, and date of drawing and revision

1.13 SUBSTITUTES

- A. Manufacturers' names and catalog numbers of materials and equipment are given to describe type, quality, and design of material and equipment required. Where possible, three (3) or more manufacturers are listed.
- B. Where materials or manufacturers are specified, and where the words "or equal" or "approved equal" are not used, only those specified shall be furnished and installed.

1.14 MATERIALS AND EQUIPMENT REQUIREMENTS

- A. Provide materials and equipment conforming to those specified herein. Manufacturers' names and catalog numbers are given to describe type, quality and design of material and equipment required.
- B. All material and equipment shall conform to capacity, efficiency, design, and material specified, and shall meet all dimension and space requirements. Sizes of materials and equipment indicated, or specified, are minimum requirements. The Contractor may use larger sizes to expedite the work provided that such change meets space requirements and does not result in additional installation, maintenance or operating cost to the Owner. Equipment or materials of the same type or classification, used for the same purpose, shall be the products of the same manufacturer.
- C. All materials shall be new, unused (temporary lighting and power products are excluded), and free from defects, of the best of their respective kind, and shall conform to accepted standards of the trade in every case where such a standard has been established for the particular type of material in question. Equipment and accessories not specifically described or identified by manufacturer's catalog numbers shall be designed in conformity with applicable technical standards and specifications of societies, organizations, and/or agencies listed herein, suitable for maximum working pressure and shall have neat and finished appearance.

- D. Materials and appliances of types for which there are UL standard requirements, listings, or labels shall conform to the Underwriter's Laboratory, Inc. requirements, and bear the UL listings and labels.
- E. In all cases where a device or part of the equipment is herein referred to in the singular number, it is intended that such reference shall apply to as many such items as are required to complete the installation.
- F. Contractor shall, without charge, replace any work or material, which develops defects, except ordinary wear and tear, or fail to perform satisfactorily, within one (1) year from the date of final acceptance.

1.15 DEMOLITION WORK

- A. Contractor shall remove all existing electrical work becoming inactive under this project. Removal of electrical work shall include removal of all appurtenances existing conduit, wiring, disconnect switches, devices, etc.
- B. Unless noted otherwise the Contractor shall have salvage rights to all electrical work removed under this project. All removed electrical work shall be removed from premises.

PART 2 PRODUCTS

Not Applicable

PART 3 EXECUTION

Not Applicable

END OF SECTION

SECTION 16050

ELECTRICAL BASIC MATERIALS & METHODS

PART 1 – GENERAL

1.01 SCOPE

- A. Provide material and perform all work necessary to furnish a complete, functional installation as outlined in this and associated Specifications, and associated project drawings. Installation consists of provisions for secondary service with secondary metering, lighting, power, control, enclosed breakers, panelboards, disconnects, conduit and wiring, receptacles, toggle switches and control devices.
- B. Contractor shall consult Section 16010, General Provisions, in detail, as s/he will be responsible for and governed by conditions set forth therein.

1.02 SUBMITTALS

Furnish shop drawings and descriptive data, complete with project designation for the following:

- A. Conductors/Cables
- B. Conduits
- C. Wiring Devices
- D. Thermostats
- E. Outlet Boxes and Fittings
- F. Junction and Pull Boxes
- G. Disconnect Switches

PART 2 – PRODUCTS

2.01 CONDUCTORS/CABLES

- A. Power:
 - 1. Copper, single- or multi-conductor, 600 volts, THWN-2, 90°C dry and wet.
 - 2. Minimum wire size for branch circuits shall be #12 AWG, except non-power carrying control circuits may be #14 AWG.
 - 3. Conductors #8 AWG and larger shall be stranded.
 - 4. Multi-conductor cables shall be type TC.
 - 5. Manufacturers: Cablec, ITT-Royal, or Southwire.
- B. Instrumentation/Control:
 - 1. 300-volt rated for instrumentation and control.
 - 2. Soft-annealed, bare #18 AWG copper conductors in a cable with an overall shield. Number of pairs and conductor gauge shall be as indicated.
 - 3. NEC Type PLTC listed. UL Standard 13.
 - 4. 105-degrees Celsius PVC-insulated conductors with an overall PVC jacket.
 - 5. Aluminum polyester foil tape with tinned copper drain for 100% coverage.
 - 6. Manufacturers: Alpha, Belden, Coleman, or Dekoron.

2.02 CONDUITS

- A. Rigid Galvanized Steel Conduit:
1. Material: Hot dipped galvanized rigid steel.
 2. Fittings: Cast metal, screwed fittings; 1-1/2" and larger, mogul type. (Zinc coupling or nonferrous metal fittings are not acceptable).
 3. Standards: ANSI C80.1, ANSI C80.4 and UL6.
 4. Manufacturers: Allied, O-Z/Gedney, Robroy, Thomas & Betts, Triangle, Wheatland
- B. Rigid Aluminum Conduit:
1. Material: Aluminum
 2. Fittings: Cast copper-free aluminum screwed fittings: 1-1/2" and larger, mogul type.
 3. Standard: UL listed and labeled.
 4. Manufacturers: Anaconda, American Brass Co., Reynolds Metal Co., Robroy, O-Z/Gedney, Thomas & Betts
- C. Rigid Polyvinyl Chloride Conduit (PVC):
1. Material: Polyvinyl chloride, rigid conduit, listed for 90°C conductors or cable and use in direct sunlight. Use Schedule-80 for underground installations and Schedule-40 for above-ground installations.
 2. Fittings: Coupling type.
 3. Joints: Connections shall be made by solvent welding.
 4. Standards: NEMA, UL, NEC, ASTM D 1784.
 5. Manufacturers: Carlon, O-Z/Gedney, Robroy, Thomas & Betts, Triangle.
- D. Liquid-tight flexible metallic conduit (LFMC):
1. Flexible, galvanized-steel core, with continuous copper ground in the convolutions, covered with extruded polyvinyl chloride.
 2. Connectors: Nylon-insulated screw-in ground core type connectors, constructed of malleable iron Thomas & Betts Liquid-tight fittings or equal.
 3. Manufacturers: Electri Flex, Thomas & Betts, O-Z/Gedney, Robroy, Triangle.

2.03 WIRING DEVICES

- A. Manufacturers: Arrow-Hart, Hubbell, or Bryant devices equivalent to those listed herein.
- B. Wall switches: Hubbell No. HBL-1221, -1222, -1223, and -1224, 20 ampere, 120/277 volt, brown nylon toggle, back and side wiring, single-pole, two-pole, three-way, or four-way as indicated.
- C. General Purpose Receptacles: Hubbell No. HBL5362, duplex type with grounding, 20 ampere, 125 volt, brown nylon face, back and side screw terminals.
- D. Indoor GFCI Receptacle: Hubbell No. GF20L, duplex, 20 ampere, 125 volt, brown nylon face, back and side screw terminals, flashing red failure indicator, with test and reset buttons.
- E. Outdoor GFCI Receptacle: Hubbell No. GFR5362TR, weather-resistant, duplex, 20 ampere, 125 volt, brown polyester face, back and side screw terminals, flashing red failure indicator, with test and reset buttons.

- F. Wall Plates:
 - 1. Indoor wall devices: Hubbell, Series NP, smooth finish gray nylon, standard size plates provided to match wiring device.
 - 2. Outdoor GFCI Receptacle: Hubbell, Series WP26, while-in-use cast aluminum weatherproof cover, selected for vertical or horizontal mounted device.

2.04 OUTLET BOXES AND FITTINGS

- A. Cast boxes, Fittings, and Conduit Bodies:
 - 1. Standard, general purpose, copper-free cast aluminum boxes with threaded inlets, gaskets, cast aluminum fittings, and conduit bodies with gasketed cover.
 - 2. Choice of body types shall be made to conform to installation arrangement, wiring, device content, etc.
 - 3. Sealing fitting shall be expanded-filling type, rated for Class I, Division 1, Groups B, C, D, provided with fiber filler and sealing compound.
 - 4. Aluminum metallic finish.
 - 5. Manufacturers: Crouse Hinds, Appleton, or Killark.

2.05 JUNCTION AND PULL BOXES

- A. Smaller than 150 cubic inches: Standard NEMA-4X outlet box with cover.
- B. 150 cubic inches and larger: Construct same as NEMA-4X cabinets conforming to UL "Standards for Cabinets and Boxes".
- C. Junction and pull boxes shall be:
 - 1. NEMA Type-4X enclosure
 - 2. Type-316L stainless steel enclosure and exterior hardware
 - 3. Type-316L stainless steel hinged door, clamps, hasp and stable for padlocking, and neoprene gaskets
 - 4. External mounting brackets
 - 5. Manufacturers: Hoffman Bulletin A4S, or equal

2.06 CONNECTORS

- A. Connectors:
 - 1. Conductors #8 AWG and larger terminated and spliced with Burndy or Thomas & Betts mechanical pressure connectors.
 - 2. Conductors #10 AWG and smaller terminated and spliced with insulated expandable live spring type twist-on compression type connectors. Connectors shall be Buchanan "B-Cap" or 3M "Hy-Flex".
 - 3. Connect conductors to apparatus by means of approved lugs or connectors as manufactured by Thomas & Betts, or equal.
- B. Insulating tape:
 - 1. Vinyl plastic insulating tape, 7-mil thick, Scotch 33+ or equal.
 - 2. Apply at all joints and splices.

2.07 DISCONNECT SWITCHES

- B. General Disconnects:
 - 1. Type: Heavy duty, single-throw, non-fusible except as indicated otherwise.

- Rating and size as indicated.
2. Terminal lugs: UL listed for copper cables and front removable.
 3. Switch blades: Blades shall have quick make and quick break operating handle with dual cover interlock to prevent door opening in "ON" position.
 4. Solid neutral bus shall be provided where neutral conductors exist in the disconnect.
 5. Enclosure: NEMA-4X Stainless Steel
 6. Electrical interlock: One normally open contact on all switches on equipment served by power and control wiring.
 7. Manufacturers: Square-D "Heavy Duty", or equal of Cutler-Hammer or Siemens.

PART 3 – EXECUTION

3.01 CONDUIT CLASSIFICATION

- A. Rigid galvanized steel conduit shall only be used when specifically noted on drawings for wiring installed underground or under floors, and shall rise a minimum of 6 inches above the surface where emerging from below.
- B. Rigid aluminum conduit shall be used for all building wiring. Aluminum conduits shall not be placed in contact with concrete or installed underground. Installation shall be in accordance with supports and hangers specified herein.
- C. PVC conduit shall be used for underground secondary service, and as indicated on drawings. Use Schedule-80 for underground installations
- D. Liquid-tight flexible metal conduit shall be used for final connections to motors, instruments or other equipment to facilitate removability and items subject to motion or vibration (length: 2-feet max.).

3.02 CONDUIT INSTALLATION

- A. Install conduit in accordance with the following:
 1. Generally, conduits in the building are to be installed exposed on walls and ceilings unless otherwise indicated. Conduits may be run concealed in accessible ceiling spaces where applicable. Minimum size conduit shall be 3/4". Other sizes shall be as indicated or required by the National Electrical Code for number and size of conductors installed.
 2. All joints shall be cut square, reamed smooth, and made up tight. Rigid metal conduit shall be threaded. Bends or offsets in metal conduit shall be made with conduit ells, field bends made with approved bender or hickey, or hub type conduit fitting. Radius of bends shall conform to the National Electrical Code. Number of bends per run shall conform to National Electrical Code limitations. All scratched, cut, threaded, or where galvanized finish is disturbed and has exposed steel in the conduit system shall have two coats of Zinc-Rich's ZR or Zink-X applied after cleaning off dirt, chips, and oil.
 3. Concealed and exposed conduits shall be run with long sweep bends and offsets (parallel to and at right angles to building lines).
 4. Conduits shall be continuous from outlet to outlet and from outlets to cabinets, pull or junction boxes, and shall be secured to all boxes with locknuts and bushings in such a manner that each system shall be electrically continuous

throughout. Conduit ends shall be capped to prevent entrance of foreign materials during construction.

5. Conduit terminations at cabinets and boxes shall be rigidly secured with locknuts and bushings as required by the National Electrical Code. On all conduit 1-1/4" trade size and larger, bushings shall be of the insulated or insulating type with double locknuts as manufactured by Thomas & Betts or approved equal.
6. All conduit systems must be installed complete before conductors are pulled. All empty raceways shall have a #12 galvanized-steel pull wire installed, with 12-inches coiled in box for future wire pulling.
7. All underground conduits entering building shall be effectively sealed to prevent water moisture, or any other foreign matter, from entering building.
8. Underground conduit system shall consist of wide sweep elbows and bends and shall be completely watertight. Conduits shall be not less than 30" below finish grade.
9. Route of all underground conduits to be identified by placing a continuous plastic tape in the trench backfill, six to eight inches below finished grade. The tape is to be non-biodegradable type plastic at least 4" wide, red in color, and imprinted with the legend "Caution - Buried Electric Lines Below".

B. Support conduit in accordance with the following:

1. Horizontal and vertical conduit runs shall be supported by one-hole malleable straps, clamp backs, split ring, or other approved devices with suitable machine threaded bolts. Provide concrete inserts, expansion anchors, and strut assemblies for mounting to building concrete structure. See "SUPPORTS AND HANGERS" section on requirements for electrical work being mounted on masonry surfaces, steel beams, and on columns.
2. Trapeze hangers may be used to support groups of parallel conduits; U-bolt or similar type clamps shall be used at the end of a conduit run and at each elbow, J-bolts or approved clamps shall be installed on each third intermediate trapeze hanger to fasten each conduit.
3. Hangers shall be made of malleable iron and have a steel insert that bites into structural member and shall be suitable for the application involved. Finish shall be electro-plated. Where excessive corrosive conditions are encountered, hanger assemblies shall be protected, after fabrication, by sherardizing or galvanizing, special paint, or other suitable preservative methods.

3.03 SUPPORTS AND HANGERS

- A. All conduits shall be secured and supported in accordance with the National Electrical Code.
- B. Conduits shall be supported by Unistrut or Kindorf channels and straps, or equal, with prior approval, or by beam clamps fastened to building steel.
- C. Continuous rigid cable supports, such as wire ways, cable troughs, ladders and channels, shall be supported by brackets or hangers made of Unistrut or Kindorf channels, or equal with prior approval.
- D. No electrical equipment of any nature shall be fastened directly to masonry surfaces, steel beams, or columns. Lengths of Unistrut or Kindorf steel channel shall first be fastened to the structure, and then the electrical equipment fastened to the steel channel with metal fasteners designed for the purpose.

- E. Where steel supporting channels are fastened to masonry walls, toggle bolts, expansion shields or through bolts shall be used. Wood plug masonry anchors shall not be used.
- F. The required strength of the supporting equipment, and the size and type of anchors, shall be based on the combined weight of conduits, hangers, and cables.

3.04 JUNCTION AND OUTLET BOX INSTALLATION

- A. Install junction and outlet boxes approximately as indicated:
 - 1. Set boxes true and flush, and rigidly secure in position.
 - 2. Use painted or galvanized iron hangers to support ceiling outlets.
 - 3. Set boxes so that front edges of box are flush with finished wall or ceiling line, or not more than 1/4" back of same, except where conduit is exposed.
- B. Provide junction and outlet boxes of sizes and types to accommodate the following:
 - 1. Structural conditions
 - 2. Size and number of conductors, or cables, entering
 - 3. The device or fixture for which the box is required

3.05 CONDUCTOR INSTALLATION

- A. Install conductors of size and quantity indicated or required in accordance with requirements of the National Electrical Code.
 - 1. Do not draw conductors into conduit until conduit is free from moisture.
 - 2. Leave sufficient slack to permit connection of fixtures, switches and equipment without additional splices; 8" minimum.
 - 3. Minimum wire size for branch circuits shall be #12 AWG except that home runs longer than 100 feet from panel to load shall be minimum #10 AWG.
 - 4. Each motor shall be supplied by an individual branch circuit, unless indicated otherwise.
- B. Make taps and splices in wire as follows:
 - 1. Conductors shall be square cut with a hacksaw or cable cutter without deforming the strands. Insulation shall be removed with a penciling cut to avoid nicking the strands and surface oxides shall be removed by brushing exposed strands with a wire brush or card file.
 - 2. Compression connectors shall be selected to fit the conductor.
 - 3. Splice only in accessible pull, junction, or outlet boxes.
 - 4. Use mechanical wire splices and joints for #8 wire and larger, and AL/CU pressure connectors for #10 wire or smaller.
 - 5. Insulate joint at least 100% in excess of wire insulation.

3.06 GROUNDING

- A. Applications:
 - 1. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
 - 2. Encased electrodes of building footing and column footing reinforcing assembly in accordance with NFPA 70 and as detailed on the drawings.
 - 3. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor

where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

4. Conductor Terminations and Connections:
 - a. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - b. Underground Connections: Welded connectors except at test wells and as otherwise indicated.

B. Equipment Grounding:

1. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - a. Feeders and branch circuits.
 - b. Lighting circuits.
 - c. Receptacle circuits.
 - d. Three-phase motor and appliance branch circuits.
 - e. Flexible raceway runs.
2. Instrumentation Equipment and Control Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and control panels.
3. Instrumentation and Control Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
4. Control Cabinets: Terminate grounding conductor on cabinet grounding terminal.

C. Installation:

1. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
2. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
3. Concrete Encased Electrodes: Established grounding systems with concrete encased electrodes as detailed on drawings and in compliance with NFPA 70. Coordinate installation with structural contractor.
4. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - a. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - b. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - c. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
5. Grounding and Bonding for Piping: Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
6. Bonding Interconnect in metallic Boxes: Interconnect conduit grounding

bushing with #12 AWG bare copper conductor bonded to metallic box.

- D. Labeling: Comply with requirements in Section 16050 "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

3.07 LOAD BALANCE

- A. Connect panelboard branch circuits so as to obtain a maximum load balance variance of 10% between feeder circuit phases under full-load conditions.
- B. Provide suitable instruments to determine phase loading. Perform and document tests as required by the Engineer.

3.08 CUTTING AND PATCHING

- A. Contractor shall install all hangers, supports and sleeves in floors, walls, partitions, ceilings, and roof slabs as construction progresses to permit their work to be built into place and to eliminate unnecessary cutting of construction work.
- B. All cutting of concrete or other material for the passage of conduit through floors, walls, partitions and ceilings shall be done by the Contractor where necessary to install his work. Contractor will close all such openings around conduit with material equivalent to the fire-rating and structural integrity of that removed. All exposed surfaces shall be left in suitable condition for refinishing without further work.
- C. Where conduits penetrate fire-rated walls, floors, or ceilings, seal openings with appropriate UL-approved firestop material.
- D. No structural member shall be altered or cut without the written special permission of the Engineer.

3.09 WIRING DEVICES

Where wiring devices are indicated, install device complete with outlet box and coverplate. Ground connections between device and metallic outlet box are required on both standard and self-grounding devices equipped with a ground terminal.

3.10 MOUNTING HEIGHTS - WIRING DEVICES AND SPECIAL SYSTEMS

- A. Mount wiring devices and special system outlets at height above-finished-floor (AFF) as herein specified, except where indicated otherwise.
 - 1. Receptacles 36" AFF
 - 2. Switches 48" AFF

3.11 EXCAVATION AND BACKFILLING

- A. Contractor shall perform all necessary excavation and backfilling required for the installation of their work.
- B. Excavate bottom of trenches to exact depth, refill excavation below required grade of cable or raceway with firmly compacted sand. Deposit excavated materials on side of trench; do not leave material where it will interfere with traffic. Suitably protect trenches

and openings with signs, barricades, enclosures, or flashing lights.

- C. Trenches shall not be backfilled until all required tests are performed and until the utilities systems, as installed, conform to the requirements of the various utilities for the installation. Trenches improperly backfilled shall be reopened to the depth required for proper compaction, then refilled and compacted as specified, or the condition shall be otherwise corrected as permitted by the Owner.

Lower Portion of Trench:

Backfill material shall be deposited in 6-inch maximum thickness layers and compacted with suitable tampers to the density of the adjacent soil until there is a cover of not less than one foot. The backfill material in this portion of the trench shall consist of sandy clay, sand, gravel, soft shale, or other approved materials free from hard clods and stones larger than one inch in any dimension.

Remainder of Trench:

The remainder of the trench shall be backfilled with material that is free of stones larger than 1-inch in any dimension. Backfill material shall be deposited in layers not exceeding the thickness specified, and each layer shall be compacted to the minimum density specified as applicable to the particular area.

- D. For installation involving directly buried cable, stones or pieces of paved surfacing larger than one inch in any dimension, or pieces of scrap cable, shall not be buried in the trench as a means of disposal.
- E. Routing of all underground lines is to be identified by placing a continuous plastic tape in the trench backfill 6" to 8" below finished grade. The tape is to be non-biodegradable type plastic at least 4" wide, red in color, and imprinted with the legend "Caution-Buried Electric Line Below".
- F. Construction shall be arranged so that trenches will be left open for the shortest practical time to avoid creating a hazard to the public and to minimize the likelihood of trench collapse due to other construction activity, rain, accumulation of water in the trench, etc.

3.12 ACCEPTANCE TESTING

- A. Cables – Low Voltage (600 volts and less):
- Visual and Mechanical Inspection:
 - Cables to be inspected for physical damage and proper connection in accordance with single-line diagram.
 - Cable mechanical connections shall be tested to manufacturer's recommended torque values with a calibrated torque wrench.
 - Electric Tests:
 - Perform insulation resistance test on each cable with respect to ground and adjacent cables.
 - Perform continuity test to insure proper cable connections.
 - Test Values:
 - Insulation resistance tests shall be performed at 1000 volts D.C. for one (1) minute.
 - When insulation resistance must be determined with all switchboards, panelboards, fuse holders, switches, and overcurrent devices in place, the insulation resistance, when tested at 500 volts D.C., shall be no less than

Table 3.1 below.

- Table 3.1
- MINIMUM INSULATION RESISTANCE

• Conductor or • Circuit Size	• Minimum • Resistance
• No. 14 and 12 AWG	• 1,000,000 ohms
• 25 ampere circuits and above	• 250,000 ohms

- B. Review Testing Results: Review all test data to verify overall loss values measured for each strand are acceptable and light loss budgets are maintained.

3.13 EQUIPMENT CONTROL WIRING

Provide all wiring, conduit, terminal blocks, labeling, surge protection, and final connections for the instrument and control wiring required for the proper operation of all equipment.

END OF SECTION

SECTION 16053

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.02 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.03 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

PART 2 PRODUCTS

2.01 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system type.
- C. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.02 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
- C. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.03 CONDUCTOR IDENTIFICATION MATERIALS

- A. Description: Tubing/sleeve type wire marker system. Identification labeling shall utilize sleeve identification labeling system with numbers (and/or letters) permanently printed using HEAT TRANSFER technology. Dot Matrix type print on vinyl sleeves is NOT considered acceptable.
- B. Locations: In general, each conductor or cable required to be labeled shall be identified in every panelboard gutter space, pull box, and at the load connection termination. Control and instrumentation cabling is to be identified in each device enclosure; control station, wiring termination cabinet and at main (or auxiliary) control panels. Telecommunication/Data and Instrumentation wiring shall be labeled as outlined in other Sections of these Contract Documents.
- C. Legend:
 - 1. Power and Lighting Circuits: Branch circuit or feeder number indicated.
 - 2. Control Circuits: Control wire number indicated on schematic and interconnection diagrams. All control wiring shall be tagged with a legible permanent coded wire marking sleeve. Sleeves shall be white PVC tubing with machine print black marking. Markings shall be in accordance

with the wire numbers shown on the control wiring diagrams. All I/O wiring shall be labeled. The process controllers address shall be included in the wire identification tag.

D. Manufacturers:

1. Brady
2. Seton
3. LEM
4. Panduit

2.04 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE.
3. Inscriptions for Orange-Colored Tapes: OPTICAL FIBER CABLE.

2.05 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning:

DANGER
ELECTRICAL SHOCK HAZARD
EQUIPMENT HAS MULTIPLE POWER SOURCES.

2. Workspace Clearance Warning (For 300 Volts and Below):

WARNING
OSHA REGULATION
AREA IN FRONT OF ELECTRICAL EQUIPMENT
MUST BE KEPT CLEAR FOR 36 INCHES.

3. Workspace Clearance Warning (For 600 Volts and Below):

WARNING
OSHA REGULATION
AREA IN FRONT OF ELECTRICAL EQUIPMENT
MUST BE KEPT CLEAR FOR 42 INCHES.

2.06 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.
- B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.07 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Apply identification devices to surfaces that require finish after completing finish work.

- C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- D. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- E. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.
- F. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.02 IDENTIFICATION SCHEDULE

- A. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 300 V to ground: Install labels at 30-foot maximum intervals. Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage.
- B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded feeder and branch-circuit conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes

where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

- C. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- D. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Limit use of underground-line warning tape to direct-buried cables.
 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- E. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting:
1. Comply with 29 CFR 1910.145.
 2. Identify system voltage with black letters on an orange background.
 3. Apply to exterior of door, cover, or other access.
 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
- G. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the

Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

- a. Indoor Equipment: self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.
- b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
- c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
- d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION

SECTION 16055

ELECTRICAL TESTING AND START-UP

PART 1 GENERAL

1.01 DESCRIPTION

- A. Work Included: Furnish all labor and materials required for tests, start-up and associated work required to be performed under this Contract as specified below.
- B. General:
1. The testing and start-up procedures, where indicated, shall be made by a NETA certified, independent electrical testing company. Acceptable testing companies are MET Electrical Testing Company, Inc. or Approved Other NETA Certified Testing Company. Unless otherwise indicated, the Contractor may provide electrical equipment and systems testing or may utilize the services of the independent testing company. In either case, however, the acceptance testing procedures established by the National Electrical Testing Association (NETA) shall be utilized in establishing test procedures and evaluating results. The Contractor shall provide suitable test forms for all tests conducted and shall submit all testing for review and comment to the Engineer.
 2. The Contractor shall provide all the necessary labor and equipment to perform all the testing required by this specification. The Contractor shall submit test reports for approval to the Engineer as required by this specification. Testing of the power distribution system shall be performed after completion of the coordination study.
 3. All equipment shall be demonstrated as operating properly prior to the acceptance of the work.
 4. All protective devices shall be operative during all testing of operations.
 5. Tests shall be conducted during the construction period, and the completion of records covering such work shall be the responsibility of the Contractor; all such tests and checks shall be made in strict accordance with applicable manufacturer and instructions of the Engineer.
 6. Where conditions are found during the work which requires correction or change, the Contractor shall proceed promptly with the necessary work as directed by the Engineer.

PART 2 PRODUCTS

NOT APPLICABLE

PART 3 EXECUTION

3.1 TESTING

A. Tests Performed by the Contractor:

1. The Contractor shall furnish all the necessary labor and equipment for testing in accordance with this specification. The Contractor shall be responsible for all tests and test records. Testing shall be performed by and under the immediate supervision of the Contractor and shall be performed by qualified personnel fully experienced in this type of testing.
2. The Contractor shall provide all the necessary test equipment and shall be responsible for setting up all test equipment and other preliminary work in preparation for the tests.
3. All testing shall be done in the presence of the Owner and/or his designated representative.
4. Records of all tests and inspections, with completed data of all readings taken, shall be made and incorporated into a report for each piece of equipment tested. Individual reports shall be bound together with all test reports associated with the facility. The reports shall be indexed and grouped in a logical sequence.
5. The tests specified herein apply to all equipment installed by the Contractor; any mechanical or electrical defects or damage in the Contractor's furnished equipment shall be immediately reported to the Owner or his designated representative and shall be replaced or repaired as soon as practical by the Contractor at no additional cost to the Owner.
6. Equipment supplied under other Contracts damaged by careless or improper use of testing equipment associated with this Contract, shall be replaced or repaired as soon as practical by the Contractor at no additional cost to the Owner.
7. No equipment shall be energized without the prior written approval of the Engineer.
8. Test forms shall be generated by the Contractor to document test results which the forms included with this specification do not cover. These forms shall be standardized for all tests of the specific type. Additional test forms shall be approved by the Engineer.

9. After the visual inspection of joints and connections and the application of tape and other insulating materials, all sections of the complete system or wiring shall be thoroughly tested for shorts and grounds; the Contractor shall correct all defects.
10. The ground tests shall include the following. If the ground system fails this testing, additional ground rods shall be driven and connected to the system as directed by the Engineer. The system shall then be retested until satisfactory results are obtained.
 - a. Ground resistance measurements shall be made between the equipment ground buses or connections listed below and at two alternate points on the facility's external ground grid.
 1. Motors, 20 hp and larger
 2. 480 V motor control centers and variable frequency drives.
 3. Power distribution panelboard(s) and switchboards
 - b. The maximum permissible resistance shall be 0.05 ohm between the ground bus and two ground grid points.
11. Acceptance Tests for Cables:
 - a. Perform wire and cable tests prior to connecting to equipment. All testing to be in accordance with NETA recommendations for acceptance testing.
12. Phase Rotation:
 - a. Phasing and identification of 3 phase, 60 cycle circuits, conductors and terminal shall be:
 1. ABC from top to bottom in vertical arrangement.
 2. ABC from left to right in horizontal arrangement.
 - a. Facing front of 3 phase panels.
 - b. Facing low voltage side of transformers.
 - c. Facing right end of panel or primary control cubicle (right end determined from a) above).
 - d. Facing right end of transformer bank (right end determined from b) above).

- b. Phase rotation is to be counterclockwise (this refers to electrical rotation only and not to mechanical rotation of machines).

13. Motors:

- a. Rotating machinery shall be given the following visual and mechanical inspections:
 - 1. Inspect for physical damage; compare equipment nameplate information with single-line diagram.
 - 2. Inspect for proper anchorage, mounting, grounding and connection.
 - 3. The Contractor shall compile for each motor the following data in a neatly tabulated form:
 - a. Motor number
 - b. Drive title
 - c. Horsepower
 - d. Volts
 - e. Nameplate amperes
 - f. Code letter
 - g. rpm
 - h. Service factor
 - i. Enclosure
 - j. NEMA design letter
 - k. Insulation resistance
 - l. Overload heater
 - m. Power factor
- b. This information shall be filed with the Engineer prior to start-up of any equipment.
- c. All 3 phase rotation machines larger than 20 horsepower shall be given an insulation test in accordance with NETA recommendations for acceptance testing.
- d. Provide vibration testing of Motor and Blower assemblies in accordance with applicable ISO Standards.

14. Low Voltage Motor Controllers:
 - a. Equipment shall be given the following visual and mechanical inspections:
 1. Inspect for physical damage. Compare equipment nameplate information and connections with the single-line diagram. A visual check of all starter locations, nameplates, etc. shall be made against design plans. Check for proper anchorage and grounding.
 2. Compare overload heaters with motor full load current for proper size.
 3. Check tightness of bolted connections.
 4. Check ratings of and make settings on all overcurrent protective devices.
 - b. Provide the following electrical tests.
 1. The following insulation tests shall be performed by the independent testing company:
 - a. Measure the insulation resistance of each bus section from phase to phase and from phase to ground for one minute with a 1000 volt megger; the minimum acceptable resistance shall be 100 megohms.
 2. A functional check of all wiring shall be made against applicable interconnection wiring diagrams.
 3. With control circuits properly energized, check operation of all controls and interlocks.
 - a. Mechanical and electrical operational tests shall be performed on all switches, breakers and their starters and associated alarm and indicating devices.
15. Electrical Instrumentation:
 - a. Examine all devices for broken parts, indication of shipping damage and wire connection tightness; verify meter connections in accordance with single-line meter and relay diagram.

Calibrate all meters at midscale; calibration instruments shall have a precision no more than 50% of the instrument under test.
16. Thermographic Inspection to be performed by a Level 2 NETA Certified Thermographer

- a. Perform thermographic (Infrared Scanning) inspection of the electrical equipment and installations listed herein in the presence of the Engineer. After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
- b. The thermographic inspection shall locate, by comparisons of temperature levels, high resistive points in installations of electrical materials and equipment. Comparisons are made by referencing a known ambient temperature of the object being scanned to the hot spot detected.
- c. Detection Equipment: Equipment shall consist of an infrared cameras that provided input to a display screen over a range of at least 1 degree C to 75 degrees C with the infrared emissions of the object being displayed having an accuracy of 0.1 degree C.
- d. Equipment to be tested includes the following:
 1. Panelboards
 2. Motor Controllers
 3. Dry Type Transformers
 4. Motors, including terminations
- e. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

17. FIBER OPTIC CABLE

- a. Visual inspection:
- b. Cables and strands are to be inspected for physical damage and proper termination.
- c. Verify installation complies with TIA/EIA-568-C.3

B. Final Installation Check:

1. Prior to operational testing and after Contractor's test, final checking of equipment, raceways, circuits and connections is required. Such checking will be done under the direction of the Engineer. The Contractor shall provide all necessary labor and, where requested, supervision to accompany, advise and assist

the Owner's personnel in making such checks and in recording the results. Improper or defective items discovered during the checking processes shall be listed and shall be corrected as soon as possible.

2. The requirements for preoperational checking include but are not limited to the following items:
 - a. Phase rotation and voltage of power interconnections.
 - b. All fuse and circuit breaker ratings correct as specified or shown on drawings.
 - c. All current transformer secondaries correctly wired to equipment or shorted.
 - d. Thermal overload relays in motor starters of correct ratings and properly installed.
 - e. Integrity of grounding system verified including all ground connections tight. All equipment properly grounded and bonded in accordance with the Contract requirements. All metal raceway systems electrically continuous and correctly grounded.
 - f. Power and control circuit connections completed and tight.
 - g. All motors checked for rotation, tested, clean and ready for operation, with driven equipment connected or positively and safely disconnected as may be required.
 - h. All tests performed by the Contractor and the independent testing company complete in accordance with this specification.
 - i. Valve operator and other limit switches, pressure switches and control devices correctly connected and adjusted.
 - j. Conduits properly installed in accordance with applicable documents and drawings.

C. Operational Check:

1. All equipment and all power, control and instrument circuits will be operated and checked to ensure that operation conforms to the requirements of the elementary diagrams, wiring diagrams and specifications; each component of subsystem shall be operated, checked out and necessary corrections made, and rechecked before operation of major systems is attempted.
2. The Contractor shall be responsible for the testing and calibration of all control devices and circuits.
3. The Contractor shall provide all necessary labor and, where requested, supervision to assist the Owner's designated personnel with the required operational checking

and to correct at once, as directed, any defective conditions disclosed by such preliminary operation.

4. Where checking, testing and operation reveal defects, errors or misoperation of equipment installed by others, the Contractor shall notify the Engineer at once and shall cooperate with other Contractors or trades to correct such conditions.

D. Testing Equipment:

1. Testing equipment, in sufficient numbers, to be provided by the Contractor shall include but shall not be limited to thermographic test equipment, motor driven meggers, ground test sets, timers, motor rotation indicator and instruments. All equipment shall be in good operating condition and shall be properly maintained and calibrated. The calibrations will be checked at intervals by the Engineer, and recalibration will be done whenever necessary. Submit certified calibration reports for equipment utilized.
2. Upon completion of testing, checking and preliminary operation of each item of equipment, circuit or system, the Contractor shall be responsible for any necessary maintenance and protection until the item is turned over to and accepted by the Owner's operating personnel; where periodic testing is a part of prescribed maintenance, the Contractor shall continue to make such tests and to record results according to established procedures.

END OF SECTION

SECTION 16400

SERVICE AND DISTRIBUTION

PART 1 GENERAL

1.01 DESCRIPTION

- A. Perform all work necessary and/or required and furnish all materials and equipment for a complete system of electrical service and distribution. Such work includes, but is not limited to, the following:
1. Complete power distribution system including, but not limited to, to the following:
 - a. Alterations of the existing service's main breaker.
 - b. Alterations of the existing motor control center.
 - c. Complete distribution of power to existing and new loads.
 - d. Motor Control Center motor and feeder distribution.
 2. Distribution shall include panelboards, circuit breakers, dry type transformers, conduit/wiring, and associated equipment with final connections.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Please refer to the following specification sections for additional information. The information included in these sections does not supersede any information included herein, but complements and supplements it.
- B. Related Electrical Specifications Sections:
1. Section 16010 - General Provisions
 2. Section 16050 - Basic Materials and Methods

1.03 SUBMITTALS

- A. Furnish Shop Drawings and descriptive data, complete with project designation, for the following:
1. Enclosed Circuit Breakers
 2. Panelboards and Circuit Breakers
 3. Dry-Type Transformer

1.04 ELECTRIC SERVICE

- A. The existing electric service transformer, metering and underground secondary service to the facilities shall be retained. The existing service main circuit breaker section is being refurbished with a new electronic trip circuit breaker.
- B. The electric service supply is 480Y/277 Volts, 3 phase, 4 wire.

1.05 SERVICE AND DISTRIBUTION TESTS AND INSPECTIONS

Contractor Responsibility: The Contractor shall provide all necessary supervision, labor, materials, tools, test instruments or other equipment or services and expenses required to inspect, test, adjust, set, calibrate, functionally and operationally check all work and components of the electrical systems throughout the installation. Also, the Contractor shall include the furnishing of sufficient personnel to assist operating groups in any additional checks they may require for acceptance, start-up and placing the equipment and systems into continuous service.

PART 2 PRODUCTS

2.01 ENCLOSED CIRCUIT BREAKERS

- A. Circuit breaker sizes shall be as indicted on project drawings. Minimum RMS symmetrical amperes interrupting rating shall be 18,000 at 480 volts AC.
- B. Thermal magnetic, current-limiting, with factory sealed magnetic trip unit suitable for reverse connection. Lugs shall be furnished for both line and load terminations.
- C. Enclosures: Overall circuit breaker enclosure shall be NEMA-1, UL-listed, and equipped with padlock provisions.
- D. Manufacturers: Square-D, Type J or L as required, or equal by Cutler-Hammer or Siemens

2.02 PANELBOARD AND CIRCUIT BREAKERS

- A. Panelboards:
 - 1. Type: Factory assembled dead front safety type.
 - 2. Cabinet: Constructed in accordance with UL Standard 50 for cabinets, 20" minimum width, 14 gage minimum steel.
 - 3. Door: Flush mounted with lock, two keys and typewritten directory. Doors shall be flush or surface type as required.

4. Gutters: Sizes of gutters shall be in accordance with UL Standard 67 for panelboards; 5" minimum on top, bottom and sides.
5. Finish: Rust inhibiting primer and gray baked enamel finish.
6. Bussing assembly: Copper bus structure and main lugs or main breaker shall have current ratings as indicated. Ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or bus bar not to exceed 50°C rise above ambient and constructed in accordance with UL Standard UL 67. All bus work shall be constructed of copper.
7. Safety barriers: Main lugs, main breakers and bus structure shall have proper barriers.

B. Circuit breakers:

1. Type: Bolt on, quick make and quick break type with inverse time characteristics secured through use of bimetallic tripping element supplemented by magnetic trip.
2. Interrupting capacity: Minimum RMS symmetrical amperes rated shall be:

Panelboards	240V Rated	480V Rated
Light & Power	10,000	-----
Main Distrib.	-----	25,000

3. Tripping element: Non-interchangeable, non-removable type for 225 amperes and less: interchangeable type for over 225 amperes.
4. Tripping indication: Tripping indication shall be clearly visible by operating element assuming neutral position between "on" and "off".
5. Identification: Each breaker shall be identified by an individual circuit number.
6. Multi-pole breakers: Breakers designed so that overload in one pole automatically causes all poles to open by means of common trip.
8. HACR breakers: Circuit breakers rated for use on feeding heating, air conditioning and refrigeration equipment.
9. Motor Circuit Protector Type: Adjustable instantaneous trip circuit breakers. These circuit breakers shall contain a magnetic trip element in each pole with the trip point adjustable from the front of the breaker.
9. Branch circuit breakers feeding convenience outlets shall have instantaneous

sensitive trip setting of not more than 10 times trip rating of breaker.

- C. Standards: Panelboards shall be UL listed and bear UL Label.
- D. Manufacturers: Square D panelboard Type as listed or the equal of Siemens or Cutler-Hammer.
 - 1. Distribution Panel - Type NF
 - 2. Light & Power - Type NQ

2.03 LOAD CENTERS AND CIRCUIT BREAKERS

- A. Load Centers
 - 1. Type: Indoor, dead front safety type.
 - 2. Cabinet: Constructed in accordance with UL Standard 50 for cabinets, 14" minimum width, 14 gage minimum steel.
 - 3. Door: Flush mounted with typewritten directory.
 - 4. Gutters: Sizes of gutters shall be in accordance with UL Standard 67 for load centers.
 - 5. Finish: Rust inhibiting primer and gray baked enamel finish.
 - 6. Busing assembly: Copper bus structure and main lugs or main breaker shall have current ratings as indicated. Bus bar shall be constructed in accordance with UL Standard UL 67.
 - 7. Safety barriers: Main lugs, main breakers and bus structure shall be properly barriered.
- B. Circuit breakers
 - 1. Type: Plug on, toggle action with quick make and quick break mechanism.
 - 2. Interrupting capacity: Minimum RMS symmetrical ampere rating shall be 10,000 at 240V.
 - 3. Tripping element: Non-interchangeable, non-removable type for 225 amperes and less; interchangeable type for over 225 amperes.
 - 4. Tripping indication: Tripping indication shall be clearly visible by operating element assuming neutral position between "on" and "off".

5. Multi-pole breakers: Breakers designed so that overload in one pole automatically causes all poles to open by means of common trip.
 6. Branch circuit breakers feeding convenience outlets shall have instantaneous sensitive trip setting or not more than 10 times trip rating of breaker.
 7. Provide circuit breaker handle locks for all smoke detector and fire alarm panel circuits.
- C. Standards: Load Centers and panelboards shall be UL listed and bear UL Label.
- D. Manufacturers: Square D QO or equal by Cutler-Hammer or Siemens.

2.04 DRY-TYPE TRANSFORMER

- A. Construction:
1. Type: Air insulated air cooled, for indoor applications and non-ventilated for outdoor applications.
 2. Taps: Transformer shall have two (2) 2-1/2 full capacity taps above and four (4) 2-1/2% full capacity taps below normal rated primary voltage.
 3. Core and Coil: Manufactured from high grade, non-aging, silicon steel with high magnetic permeability, low hysteresis and eddy current losses. Coils must be vacuum impregnated with non-hygroscopic, thermosetting varnish and have a final wrap of electrical insulation material designed to prevent injury to magnet wire. Visible magnet wire constructed coils will not be acceptable. The core and coil unit shall be isolated from enclosure by means of vibration absorbing mounts and be supported from base frame. Non-ventilated transformers to have an epoxy-resin encapsulated core and coil assembly.
 4. Enclosure: Air ventilated transformer enclosures to be heavy gauge sheet steel, degreased, phosphatized and finished in baked enamel, NEMA-1, designed to be rodent, bird, and tamper resistant. Non-ventilated transformers to be housed in a #304 stainless-steel, NEMA-3R enclosure.
 5. Insulation: Transformers rated 0.50 through 2 KVA shall have insulating materials rated Class B by NEMA and be designed not to exceed an 80°C rise above a 40°C ambient with a 100% continuous load applied to the secondary. Transformers rated 3 KVA through 15 KVA shall have Class H insulation and be designed not to exceed 115°C rise above 40°C ambient under the above full load conditions. Transformers 30 KVA and above shall be Class H, 115°C transformers and shall have the ability to carry a continuous 15% overload without exceeding 150°C rise above 40°C ambient.

6. Sound Level: Sound levels shall be guaranteed by the manufacturer not to exceed the following values:
 - a. 000 to 009 KVA - 40 dB
 - b. 010 to 025 KVA - 42 dB
 - c. 026 to 050 KVA - 45 dB
 - d. 051 to 150 KVA - 50 dB
 - e. 151 to 300 KVA - 53 dB
- B. Operation: Primary and transformed secondary voltages shall be as indicated.
- C. Standards: Unit shall be tested in accordance with NEMA, meet ANSI Standards, and to be UL-listed.
- E. Manufacturers: Square D, Cutler-Hammer, or Siemens.

PART 3 EXECUTION

3.01 ELECTRIC SERVICE INSTALLATION

- A. Contractor shall coordinate with the utility for the new service work.
- B. Contractor to provide grounding and bonding per utility, the National Electric Code and local Authority Having Jurisdiction requirements.

3.02 CIRCUIT BREAKER, PANELBOARD INSTALLATION

- A. Install circuit breaker and panelboard in accordance with manufacturer's recommended procedures. Provide necessary protection during construction period to insure against mechanical damage and dust accumulation.
- C. Field tests prior to energization:
 1. Megger check of phase-to-phase and phase-to-ground insulation level.
 2. Continuity.
 3. Short Circuit.
- C. Adjust operating mechanisms for free mechanical movement. Tighten bus connections and mechanical fasteners. Touch-up scratched or marred surfaces to match original finish.
- D. Connect panelboard branch circuit loads so that the load is distributed as equally as possible among the phase busses.
- E. Provide typed, not hand-written, circuit directories indicating location and nature of the loads served. Install applicable circuit directories in each panelboard.

- F. Install a 1-inch by 3-inch laminated plastic nameplate with 1/4-inch white letters on a black background on each panelboard. Nameplate lettering shall be as shown on drawings. Nameplates shall be stainless-steel screw mounted.

3.03 DRY TYPE TRANSFORMER INSTALLATION

- A. General: Install transformers in accordance with the manufacturer's written instructions and recognized industry practices to ensure that the transformer complies with the requirements and serve the intended purpose. Comply with the requirements of NEMA and NEC standards, and applicable positions of NECA's "Standard of Installation", for installation of transformers.
- B. Support: Install support channels, brackets, galvanized rod, etc. as required to suspend transformer where indicated on electrical drawings.
- C. Conduit: All conduits directly connected to transformer enclosure shall be flexible steel conduit extending for a minimum of 1 foot from enclosure. Include a ground wire, size per the NEC, in each length of flexible conduit.
- D. Insulation Tests: Prior to energization, check transformer windings for continuity. Test the insulation resistance from primary winding to secondary winding and from each winding to ground. Tests shall be made with a Biddle Megger or equivalent test instrument at a voltage of not less than 1000 VDC.
- E. Winding Current: During initial no-load energization, check current in each primary winding.
- F. Tap Settings: Measure and record load current and voltage of transformers while loaded to verify proper transformer tap settings.
- G. Engrave nameplates as specified in Section 16050 shall be attached to each transformer identifying the source and circuit number from which it is served

END OF SECTION

SECTION 16426

MAIN PROTECTIVE DEVICE

PART 1 GENERAL

1.01 SECTION INCLUDES

The Contractor shall furnish and install a Main Protective Device as herein specified and as shown on the contract drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. The following sections form a part of this section. It shall be contractor's responsibility to coordinate work of other sections with work of this section to complete the work required.

1. 16050 - Basic Materials and Method
2. 16400 - Service and Distribution
3. 16460 - Electrical Power System Studies
4. 16473 - Transient Voltage Surge Suppression

1.03 REFERENCES

The distribution switchboards and all components shall be designed, manufactured and tested in accordance with the latest applicable following standards:

- A. ANSI/NFPA 70 - National Electrical Code (NEC).
- B. ANSI/IEEE C12.1 - Code for Electricity Metering.
- C. ANSI C39.1 - Electrical Analog Indicating Instruments.
- D. ANSI C57.13 - Instrument Transformers.
- E. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
- F. NEMA KS 1 - Enclosed Switches.
- G. NEMA PB 2 - Deadfront Distribution Switchboards, File E8681
- H. NEMA PB 2.1 - Proper Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.

- I. NEMA PB 2.2 - Application Guide for Ground Fault Protective Devices for Equipment.
- J. UL 50 - Cabinets and Boxes.
- K. UL 98 - Enclosed and Dead Front Switches.
- L. UL 489 - Molded Case Circuit Breakers.
- M. UL 891 - Dead-Front Switchboards.
- N. UL 943 - Ground Fault Circuit Interrupters.
- O. UL 1053 - Ground-Fault Sensing and Relaying Equipment.
- P. UL 977 - Fused Power Circuit Devices.
- Q. Federal Specification W-C-375B/Gen - Circuit Breakers, Molded Case, Branch Circuit and Service.

1.04 SUBMITTALS

- A. Consult Section 16010 - Submittals, for shop drawing requirements on all materials specified in this section.
- B. The following information shall be submitted to the Engineer:
 - 1. Master drawing index
 - 2. Front view elevation
 - 3. Floor plan
 - 4. Top view
 - 5. Single line
 - 6. Schematic diagram
 - 7. Nameplate schedule
 - 8. Component list
 - 9. Instruments details
 - 10. Assembly ratings including:
 - a. Short-circuit rating

- b. Voltage
- c. Continuous current

11. Major component ratings including:

- a. Voltage
- b. Continuous current
- c. Interrupting ratings

C. The following information shall be submitted for record purposes:

1. Final as-built drawings and information for items listed in Paragraph 1.04, and shall incorporate all changes made during the manufacturing process.
2. Wiring diagrams
3. Certified production test reports
4. Installation and maintenance instruction

1.05 QUALIFICATIONS

- A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.06 REGULATORY REQUIREMENTS

The MCB and SPC shall be UL labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.08 OPERATION AND MAINTENANCE MANUALS

Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton / Cutler-Hammer Model Pow-Line-C Type 1

2.02 GENERAL

- A. The Main Protective Device (MPD) shall consist of an electronic trip molded cast circuit breaker and surge protective device (SPD). The MPD shall have bottom line terminals and top load terminals.
- B. The MPD shall replace the one inside the existing Westinghouse Series 2100 Motor Control Center's main service entrance section. The existing 20 inch full height main service section shall be field modified as required for installation of the new MPD and SPD.
- C. MPD and SPD shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current of 65,000 amperes symmetrical at rated voltage.
- D. Voltage rating to be as indicated on the drawings.

2.03 CONSTRUCTION

- A. MPD section shall consist of the new main overcurrent device and SPD installed in the existing free standing, dead front and NEMA Type 1 rigid assembly. Modifications of the existing entrance section including new front panel and associated hardware shall be performed in conformance with the MPD manufacture's installation requirements.
- B. All existing bussing/cabling to the existing horizontal buses (phase, neutral, ground) shall be removed and from the existing main entrance section of the existing MCC line up
- C. The modification shall retain its label as a service entrance equipment in accordance with UL requirements. The neutral and ground bus shall be bounded to the existing service grounding system.

2.04 WIRING/TERMINATIONS

- A. Small wiring, necessary fuse blocks and terminal blocks within the MPD shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
- B. Mechanical-type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size as indicated on the drawings.
- C. Lugs shall be provided in the incoming bottom line section for connection of the existing main phase and neutral conductors. Additional lugs for connection of other grounding conductors shall be provided as required.

2.05 MAIN PROTECTIVE DEVICE

- A. Electronic Trip Molded Case Circuit Breaker
 - 1. Circuit Breaker:
 - a. Circuit protective devices shall be of the molded case circuit breaker type UL Listed for 80% continuous current. Frame/Sensor ampere ratings shall be as shown on the drawings.
 - b. Provide a Fixed Instantaneous (High Level Selective Over-ride) circuit on breaker. The circuit shall have a defeatable instantaneous adjustment to allow the breaker to remain closed for up to 3 cycles during overcurrents below 65 kA RMS symmetrical short time withstand rating at 600 volts. The circuit shall instantaneously trip when current levels exceed applicable withstand ratings.
 - c. All circuit breakers shall be constructed in accordance with the following standards:
 - 1. UL 489.
 - 2. NEMA AB1.
 - 3. CSA 22.2, no. 5-M1986.
 - 4. Federal Specification W-C 375B/GEN
 - 5. IEC 157-1
 - d. Circuit breaker shall utilize a glass reinforced insulating material providing high dielectric strength. Current carrying components shall be completely isolated from the trip unit and accessory mounting area. Breaker shall have common tripping of all poles and shall be trip free. The circuit breaker

shall be UL Listed for reverse connection without requiring special construction or labeling. The breaker shall have quick-make, quick-break contacts with an overcenter toggle operating mechanism. All circuit breakers shall be equipped with electrical accessories as noted on the drawings.

- e. Circuit breaker shall be factory sealed and shall have a date code on the face of the circuit breaker. Poles shall be labeled with respective phase designations.
- f. Breaker handle and faceplate shall indicate rated ampacity. Breaker faceplate shall indicate UL and IEC certification standards with applicable voltage systems and corresponding AIC ratings.
- g. Circuit breaker escutcheon shall have International I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the “ON” or “OFF” position.
- h. Circuit breaker shall be equipped with a push-to-trip button mechanically operate the circuit breaker tripping mechanism.

2. Electronic Trip System:

- a. The integral trip system shall be self-powered and shall contain electronic components to measure ampacity, time the output from internal current sensors and initiate automatic tripping action.
- b. The entire trip system shall be a microprocessor-based, true RMS sensing design with sensing accuracy through the 13th harmonic.
- c. The continuous ampere rating of the circuit breaker shall be determined by the combination of an interchangeable rating plug, and the ampere rating switch on the circuit breaker. The ampere rating resulting from the rating sensor/switch combination shall be clearly marked on the front of the circuit breaker.
- d. Provide a means to seal the rating trip unit adjustments to discourage unauthorized tampering in accordance with NEC 240-6.
- e. Provide the following time/current curve profile adjustments to maximize system selective coordination. Each adjustment shall have discrete setting and shall be independent from all other adjustments. Switch settings:
 - 1. Long-time settings; pickup and delay
 - 2. Short-time settings; pickup and delay
 - 3. Instantaneous settings

- f. Provide local visual trip indicators for overload and short circuit functions.
- g. Provide Long Time Pickup indication to signal when load approaches or exceeds the continuous current carrying capacity of the circuit breaker.
- h. The trip system shall include a long time memory circuit to detect intermittent overcurrent conditions.

2.06 TRIP UNITS

- A. Each molded case circuit breaker microprocessor-based tripping system shall consist of three (3) current sensors, a trip unit and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True rms sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors, and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached. The trip unit shall be Cutler-Hammer type Digitrip RMS 310 or approved equal.
- B. An adjustable trip setting dial mounted on the front of the trip unit, or interchangeable ratings plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed or adjustable as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
- B. System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:
 - 1. Adjustable long-time setting (set by adjusting the trip setting dial or rating plug)
 - 2. Adjustable short-time setting and delay with selective curve shaping
 - 3. Instantaneous
- D. The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.
- E. When the adjustable instantaneous setting is omitted, the trip unit shall be provided with an instantaneous override.
- F. Breakers shall have built-in test points for testing the long-time delay, instantaneous, and ground fault functions of the breaker by means of a test set.

2.07 NAMEPLATES

- A. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background. Characters shall be 3/16-inch high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish master nameplate giving switchboard designation, voltage ampere rating, short-circuit rating, manufacturer's name, general order number, and item number.
- B. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

2.08. FINISH

- A. All exterior steel surfaces of the existing main entrance section shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchboard shall be ANSI 61 light gray.

2.09 SURGE PROTECTIVE DEVICES

- A. Provide surge protective devices served by an individual overcurrent circuit breaker for SPD's specified in Section 16475.

PART 3 EXECUTION

3.01 FACTORY TESTING

- A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.
 - 1. The MPD shall be completely assembled, wired, adjusted, and tested at the factory. After assembly, the complete switchboard will be tested for operation under simulated service conditions to ensure the accuracy of the wiring and the functioning of all equipment. The main circuits shall be given a dielectric test of 2200 volts for one (1) minute between live parts and ground, and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500 volts for one (1) minute between live parts and ground
- B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.02 MANUFACTURER'S CERTIFICATION

- A. A certified test report of all standard production tests shall be available to the Engineer upon request.

3.03 TRAINING

- A. The Contractor shall provide a training session for up to five (5) owner's representatives for one normal workday at a job site location determined by the owner.
- B. A manufacturer's qualified representative shall conduct the training session. The training program shall consist of instruction on operation of the assembly, circuit breakers, fused switches, and major components within the assembly.

3.04 INSTALLATION

- A. The Contractor shall install all equipment per the manufacturer's instructions, contract drawings and National Electrical Code.
- B. The modification of the existing main entrance section shall be performed under the direction of the manufacturer's representative(s). All necessary hardware to complete the modification shall be provided by the Contractor.

3.05 FIELD QUALITY CONTROL

- A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.
- B. Measure, using a Megger, the insulation resistance of each bus section phase-to-phase and phase-to-ground for one minute each, at minimum test voltage of 1000 VDC; minimum acceptable value for insulation resistance is 1 megohms. NOTE: Refer to manufacturer's literature for specific testing procedures.
- C. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.
- D. Physically test key interlock systems to check for proper functionality.

3.06 FIELD ADJUSTMENTS

- A. The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device evaluation study and protective device coordination study.
- B. Necessary field settings of devices, adjustments and minor modifications to equipment to accomplish conformance with an approved short circuit and

protective device coordination study shall be carried out by the Contractor at no additional cost to the owner.

END OF SECTION

SECTION 16473

SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

Description: This section describes the materials and installation requirements for a Surge Protection Device (SPD). These devices are used to protect sensitive electronics from the effects of lightning induced transients, substation switching transients, and internally generated transients resulting from inductive and/or capacitive load switching.

1.2 REFERENCES

- A. The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:
1. Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, C62.45)
 2. American National Standards Institute
 3. Federal Information Processing Standards Publication 94 (FIPS PUB 94)
 4. National Electrical Manufacturer Association (NEMA LS-1 1992 Peak Current Testing)
 5. National Fire Protection Association (NFPA 70, 75 and 780)
 6. MIL Standard 220A Method of Insertion Loss Measurement
 7. National Electric Code
 8. Underwriters Laboratories UL 1283 and UL 1449 (most recent edition)
 9. Canadian Standards (CUL)

1.3 ENVIRONMENTAL REQUIREMENTS

- A. The operating temperature range shall be -40° to 70° C (-40° to 160° F).
- B. The unit shall be capable of operation up to 13,000 feet above sea level.

1.4 SUBMITTALS

- A. Product Data: Provide catalog sheets showing voltage, physical size, IEEE let through voltage for each waveform listed, UL1449 latest revision, latest edition, suppressed voltage ratings, dimensions showing construction, lifting and support points, enclosure details, per mode and per phase peak surge current, modes of discrete suppression circuitry, warranty period and replacement terms, conductor size, conductor type and lead length.

- B. Submit product data for all components and accessories.
- C. 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. Indicate maximum size of circuit breaker or fuse to be connected for each unit.
- D. List and detail all protection systems such as fuses, disconnecting means and protective features.
- E. Provide verification that the SPD device complies with the required UL1449 latest edition, latest revision, and CSA approvals.
- F. Provide actual let through voltage test data in the form of oscillograph results for the ANSI/IEEE C62.41 Category C3 & C1 (combination wave) and A1 (ringwave) tested in accordance with ANSI/IEEE C62.45.
- G. Provide spectrum analysis of each unit based on MIL-STD-220A test procedures between 10 kHz and 100 kHz verifying the devices noise attenuation equals or exceeds 40 dB at 100 kHz.
- H. Provide electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.
- I. Provide test report from a recognized independent testing laboratory verifying the suppressor components can survive published surge current rating on a per mode basis using the IEEE C 62.41, 8x20 microsecond current wave. Test data must be on a complete SPD with internal fusing in place. Test data on an individual module is not acceptable.

1.5 QUALITY ASSURANCE AND WARRANTY

- A. The panel mounted SPD and supporting components shall be guaranteed by the manufacturer to be free of defects in material and workmanship for a period of thirty (30) years from the date of substantial completion of service and activation of the system to which the suppressor is attached. Additionally, during the applicable warranty period, any SPD which fails due to any electrical anomaly, including lightning, shall be repaired or replaced by the manufacturer without charge. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.
- B. Since "Acts of Nature" or similar statements typically include the threat of lightning to which the SPDs shall be exposed, any such clause limiting warranty responsibility in the general conditions of this specification shall not apply to this particular section. That is, the warranty must specifically provide for unlimited free replacements of the SPD in the event of failure caused by the effects of lightning and all other electrical anomalies. The warranty shall cover the entire device, not just various components, such as modules only.
- C. Provide electrically operated equipment specified in this Section that is listed and labeled. As defined in the National Electrical Code, Article 100, Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA

Regulation 1910.7.

- D. Comply with NFPA 70 and NEMA LS1.

1.6 MANUFACTURER QUALIFICATIONS

- A. The SPD's shall be manufactured in the USA by a manufacturer that has been regularly engaged in the design, manufacturing and testing of SPD's of the types and ratings required for a period of not less than five years. Manufacturers requesting product approval must meet or exceed the written specification contained herein. Manufacturers requesting approval must receive written verification of product acceptance by the specifying engineer 10 days prior to the bid date.
- B. The manufacturer's test laboratory shall be certified under ETL's, UL's or other nationally recognized test lab's client Test Data Submittal Program to conduct testing in accordance with UL 1449 (most recent edition) (Standard for Safety for Transient Voltage Surge Suppressors) and UL 1283 (Standard for Safety for Electromagnetic Interference Filters) covering Transient Voltage Surge Suppression, duty cycle, Dielectric Voltage Withstand and Leakage Current Tests. In addition, the manufacturer's test laboratory shall be certified under a nationally recognized test laboratory's Client Test Data Submittal Program to conduct testing in accordance with the new UL classification Program for evaluation of transient voltage surge suppressors in accordance with a IEEE C62.41-1991, recommended practice on surge voltages in Low-voltage AC power circuits.

PART 2 PRODUCTS

2.1 PERFORMANCE

- A. General
 - 1. The SPD shall be listed by ETL, UL, or other nationally recognized test laboratory to UL's 1283 and UL's 1449 standards (latest edition, latest revision), and not merely the components or modules. All SPD's shall be Type 1 for use in Type 1 and Type 2 locations.
 - 2. The SPD shall protect all modes L-G, L-N, L-L, and N-G, have discrete suppression circuitry in L-G, L-N and N-G, and have bidirectional, positive and negative impulse protection. Line-to-neutral-to-ground protection is not acceptable where line-to-ground is specified, and accordingly reduced mode units with suppression circuitry built into only 4 modes are not acceptable. In delta systems, line-to-ground-to-line protection is not acceptable where line-to-line is specified.
 - 3. Obtain all surge suppression devices through one source from a single manufacturer.
 - 4. The maximum continuous operating voltage (MCOV) of all components shall not be less than 125% for a 120V system and 120% for 220 and 240V systems, and 115% for 277 and 480V systems.
 - 5. All SPD's shall be equipped with a comprehensive monitoring system which shall include a visual LCD panel display providing information on unit status and phase loss/protection loss.

6. All SPD's shall be Total Protection Solutions. No unit will be accepted as an "approved equal" unless it meets the warranty, strength, safety features, IEEE let-through levels, modes of discrete suppression circuitry, fusing, independent per mode surge testing, and all other requirements of this specification.
7. If a disconnect switch is specified, the disconnect switch and the SPD as a system shall be capable of interrupting up to a 200kA symmetrical fault current with 600 VAC applied.
8. Each design configuration shall have the maximum single pulse surge current capacity per mode verified through testing at an independent, nationally recognized test laboratory. To be considered for approval, the manufacturer must submit a test report on a unit which was tested with internal over current fusing in place. The test shall include a 1.2 X 50 μ sec 6000V open circuit voltage waveform and an 8 X 20 μ sec 500A short circuit current waveform to benchmark the unit's suppression voltage, followed by a single pulse surge of maximum rated surge current magnitude with an approximated 8 X 20 μ sec waveform. To complete the test, another identical surge shall be applied to verify the unit's survival. Compliance is achieved if the suppression voltages found from the two impulses do not vary by more than +10%. Test data on an individual module is not acceptable.

B. Incoming Service Protection:

1. SPD(s) for this location shall be as indicated on project drawings. SPD shall be external. SPD's shall be certified to UL 1283 and UL1449 Third Ed. Type 1 for use in Type 1 and Type 2 locations.
2. Protection shall be by a Total Protection Solutions individually mounted Series ST SPD for 480V, 3-phase, 4-wire system. The incoming service shall be protected by a Total Protection Solutions panel mounted model TK-ST240-3Y480-L for a 480Y/277 Volt, 3 phase, 4 wire plus ground system.
3. The manufacturer shall provide written specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 2002, categories B3/C1 and C3 bi-wave, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, and UL suppressed voltage ratings, all of which shall be no higher than:

ANSI/IEEE C62.41-1991 Measured Limiting Voltage

B3/C1 Impulse (6kV, 3kA)					
Voltage	(Voltage Code)	L-N	L-G	L-L	N-G
120/208	(3Y208)	590V	644V	980V	603V
277/480	(3Y480)	1010V	1022V	1740V	957V
480	(480NN)		1500V	1720V	

C3 Impulse (20kV, 10kA)					
Voltage	(Voltage Code)	L-N	L-G	L-L	N-G
120/208	(3Y208)	970V	1160V	1430V	1100V
277/480	(3Y480)	1540V	1600V	2260V	1550V

480 (480NN) 2760V 2340V

UL Voltage Protection Ratings					
Voltage	(Voltage Code)	L-N	L-G	L-L	N-G
120/208	(3Y208)	700V	700V	1200V	700V
277/480	(3Y480)	1000V	1000V	1800V	1000V
480	(480NN)		1800V	1800V	

4. The unit shall have a peak surge current per phase no less than the levels indicated on drawings with 8 X 20 us waveform, single impulse rating verified by third party test reports.
5. Internal Fusing - Overcurrent Protection:
 - a. Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Overcurrent fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode overcurrent fusing is not acceptable where there is more than one MOV per mode.
 - b. For arc quenching capability, minimization of smoke and contaminants in the event of a failure, and to ensure the safest possible design, all surge components, current carrying paths and fusing shall be packed in fuse grade silica sand.
 - c. Fusing shall be present in every mode, including Neutral-to-Ground.
 - d. The fusing shall be capable of interrupting up to a 200kA symmetrical fault current with 600VAC applied.
6. The SPD shall come standard with not less than a Thirty Year Warranty, and the warranty shall include unlimited free replacements of the unit if destroyed by lightning or other transients during the warranty period. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.
7. The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability, and shall have at minimum a NEMA 4 steel enclosure.
8. The SPD shall have an internal audible alarm with mute on front cover.

C. Lighting Panel Protection:

1. SPD(s) for this location shall be as indicated on project drawings. SPD shall be separate from panelboard. Integral SPD shall not be acceptable. SPD's shall be certified to UL1283 and UL1449 Third Ed. Type 1 for use in Type 1 and Type 2 locations.
2. Lighting panels shall be protected by a Total Protection Solutions panel mounted Series LP SPD, model TK-LP120-3Y208-L-F for 208Y/120 (4W+G) volt panels.
3. The manufacturer shall provide written specifications showing let-through voltage of

the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 2002, categories A1 & A3 ring wave, 180 degree phase angle, category B3 Ringwave, and UL suppressed voltage ratings, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, which shall be no higher than:

ANSI/IEEE C62.41-1991 Measured Limiting Voltage

A1 Ring Wave (2kV, 67A), Tested at 180 degree phase angle

Voltage	(Voltage Code)	L-N	L-G	L-L	N-G
120/240	(1S240)	29V	46V	39V	40V
120/208	(3Y208)	29V	46V	39V	40V
277/480	(3Y480)	34V	54V	40V	39V

A3 Ring Wave (6kV, 200A), Tested at 180 degree phase angle

Voltage	(Voltage Code)	L-N	L-G	L-L	N-G
120/240	(1S240)	56V	61V	88V	112V
120/208	(3Y208)	56V	61V	88V	112V
277/480	(3Y480)	66V	115V	83V	94V

B3 Ring Wave (6kV, 500A), Tested at 180 degree phase angle

Voltage	(Voltage Code)	L-N	L-G	L-L	N-G
120/240	(1S240)	437V	592V	612V	324V
120/208	(3Y208)	437V	592V	612V	324V
277/480	(3Y480)	670V	785V, 1	020V, 3	24V

UL Voltage Protection Ratings

Voltage	(Voltage Code)	L-N	L-G	L-L	N-G
120/240	(1S240)	700V	700V	1000V	700V
120/208	(3Y208)	700V	700V	1000V	700V
277/480	(3Y480)	1200V	1200V	2000V	1200V

4. The unit shall have a peak surge current of no less than 120kA/phase, 60kA/mode, 8 X 20 us waveform, single impulse, verified by third party test reports.
5. Internal Fusing - Overcurrent Protection:
 - a. Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Overcurrent fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode overcurrent fusing is not acceptable where there is more than one MOV per mode.
 - b. For arc quenching capability, minimization of smoke and contaminants in the event of a failure, and to ensure the safest possible design, all surge components, current carrying paths and fusing shall be packed in fuse grade silica sand.
 - c. Fusing shall be present in every mode, including Neutral-to-Ground.

- d. The fusing shall be capable of interrupting up to a 200kA symmetrical fault current with 600VAC applied.
- e. The SPD shall be capable of attenuating internally generated ringing type transients and noise, and shall have an enhanced transient filter supported by a specification sheet which lists the IEEE A1 Ring Wave let-through levels no higher than those set forth above.
- f. Because of space limitation, the enclosure shall not exceed 4.0" D x 4.0" W x 10.3" H to allow close-to-the load installation on flush mount panels and between adjacent panelboard. For recessed panels, a flush mount cover plate shall be provided with each unit.
- g. The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability, and shall have at minimum a NEMA 1 steel enclosure.
- h. The SPD shall come standard with not less than a Thirty Year Warranty, and the warranty shall include unlimited free replacements of the unit if destroyed by lightning or other transients during the warranty period. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.
- i. The SPD shall have an internal audible alarm with mute on front cover.

D. Coaxial Cable Protection:

- 1. Telemetry antenna coaxial cable shall be protected as indicated on project drawings.
- 2. SPD shall be solid state with a 10 year free replacement warranty.
- 3. Modes of protection: All modes: center conductor to ground.
- 4. Response time: < 1 nsec.
- 5. Insertion loss: < 0.5db
- 6. Connection type: F
- 7. Operating frequency: as required.
- 8. SPD shall be a Total Protection Solutions type TK-CT2.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install the SPD's with the conductors as short and straight as practically possible.
- B. Follow the SPD manufacturer's recommended installation practice as outlined in the equipment installation manual. The electrical contractor shall ensure that all neutral conductors are bonded to the system ground prior to installation of the associated SPD.

- C. The SPDs ground shall be connected to the power system ground.
- D. The installing contractor shall comply with all applicable codes.

END OF SECTION

SECTION 16481

MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 SCOPE

- A. The Contractor shall furnish and install the low voltage motor starters as specified herein and as shown on the contract drawings.

1.02 RELATED SECTIONS

- A. Section 16400 – Service and Distribution
- B. Section 16481 – Motor Controllers
- C. Section 16900 – Electrical Control and Instrumentation

1.03 REFERENCES

- A. The motor starters shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA, ANSI and UL.

1.04 SUBMITTALS

- A. Consult Section 16010 - Submittals, for shop drawing requirements.

1.05 QUALIFICATIONS

- A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
 - 1. Regulatory Requirements

1.06 DELIVERY, STORAGE AND HANDLING

Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.04 WARRANTY

Manufacturer shall warrant equipment to be free from defects in materials and workmanship for one (1) year from date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Eaton / Cutler-Hammer products

2.02 MANUAL MOTOR CONTROL

A. Single-Phase Manual Starters

1. Manual single-phase starters 1 hp or smaller shall be Cutler-Hammer type MS starters or approved equal. The starter shall have a quick-make/quick-break toggle mechanism. The overload shall have a field adjustment allowing up to +/- 10% variance in ratings of the nominal heater value.
2. Manual single-phase starters above 1 hp shall be Cutler-Hammer type B100 or approved equal. The starter shall have quick-make/quick-break mechanism. The closure of the contacts shall be blocked while the line terminals are exposed. The operating handle or button shall clearly indicate whether the unit is ON, OFF or TRIPPED.
3. The enclosure shall be watertight NEMA 3, 4, 5.

B. Three-Phase Manual Starters

1. Manual three-phase motor starters shall be Cutler-Hammer type B100 or equal. The starter shall have quick-make/quick-break operating mechanism. The operating handle or button shall clearly indicate whether the unit is ON, OFF or TRIPPED.
2. The closure of the contacts shall be blocked while the line terminals are exposed.
3. The enclosure shall be watertight NEMA 3, 4, 5.

C. Three-Phase Manual Motor Starter and Protector

1. The starter shall have an adjustable Class 10 ambient compensated integral overload relay and a fixed magnetic short-circuit trip mechanism designed to trip at twelve (12) times the maximum current rating of the starter.
2. The starter shall be UL listed and CSA certified for group motor installations with 1200 ampere maximum fuse and circuit breaker ratings at 480 VAC.
3. The starter shall have provisions for padlocking in the OFF position.

4. The starter shall have accessories such as auxiliary contacts, trip alarm, undervoltage release, and shunt trip available for field installation.
5. The enclosure shall be general purpose NEMA 1.
6. Motor starter and protector shall be Cutler-Hammer type or equal.

2.03 MAGNETIC MOTOR CONTROL

A. Non-Reversing Starters

1. Magnetic starters through NEMA Size 9 shall be equipped with double-break silver alloy contacts. The starter must have straight-through wiring.
2. Coils shall be permanently marked with voltage, frequency and part number.
3. Solid-State Overload Relay C440.
 - a. Provide a solid-state overload relay for protection of the motors. The relay shall be Eaton C440 or approved equal.
 - b. The overload relay shall 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.
 - c. The overload relay shall be modular in design, be an integral part of a family of relays to provide a choice of levels of protection, be designed to directly replace existing electromechanical overload relays, and be listed under UL Standard 508.
 - d. The overload relay shall have the following features:
 - 1) Self-powered.
 - 2) Class 10A, 10, 20, or 30 selectable tripping characteristics.
 - 3) Manual or automatic reset.
 - 4) Available 24 VDC, 24 VAC, or 120 VAC Electronic reset.
 - 5) Reset capabilities through onboard fieldbus.
 - 6) Selectable (On/Off) Phase loss protection. The relay shall trip in 10 seconds or less under phase loss condition.
 - 7) Selectable (On/Off) Phase Imbalance protection. The relay shall trip in 10 seconds or less under phase imbalance condition.
 - 8) Visible trip indication.
 - 9) One normally open and one normally closed isolated auxiliary contact.
 - 10) Test button that operates the normally closed contact.
 - 11) Test trip function that trips both the normally and normally closed contacts.
 - 12) A current adjustment range of 5:1 or greater.
 - 13) Available embedded, selectable (On/Off) Ground fault protection. Relay shall trip when ground fault is detected at 50% of full load ampere setting.
 - 14) An LED that provides self-diagnostic information.

- 15) An LED that aids in commissioning by indicating running current is too high compared to the FLA dial.
- 16) Available Modbus, DeviceNet, Modbus TCP, EtherNet/IP or Profibus Communication.
- 17) Available additional Inputs and Outputs (4 in and 2 out additional). Inputs shall be 120 VAC, or 24 VDC, and outputs shall be discrete relay outputs.
- 18) Diagnostic Trip Information indicating a specific trip on either ground fault, phase loss, phase imbalance, or thermal.
- 19) When using any of the available fieldbus the relay shall be capable of providing the following data monitoring:
 - a) Individual Phase Currents
 - b) Average RMS Current
 - c) Thermal Capacity
 - d) % Phase unbalance
 - e) GF Current
 - f) Line Frequency
 - g) Relay settings
 - h) Contactor Status

4. NEMA Size 00 through 2 starters shall be suitable for the addition of at least six (6) external auxiliary contacts of any arrangement normally open or normally closed. Size 3 through 8 starters shall be suitable for the addition of up to eight (8) external auxiliary contacts of any arrangement normally open or normally closed

B. Options and Features:

1. Auxiliary Contacts: NEMA ICS 2, minimum or 2 field convertible contacts in addition to seal-in contact and as required by the control circuit.
2. Cover Mounted Pilot Devices: NEMA ICS 2, oil tight type.
3. Push buttons: Recessed type.
4. Indicating Lights: Transformer push to test type.
5. Selector Switches: Rotary type.
6. Relays: NEMA rated.
7. Control Power Transformers: 120-volt secondary, 40 VA minimum larger than starter coil and control circuit loads in each motor starter. Provide primary and secondary fusing, and bond un-fused leg of secondary to enclosure.

C. Manufacturer: Cutler-Hammer Freedom Series or approved equal.

2.04 COMBINATION MAGNETIC MOTOR CONTROLLERS

A. Description: Combined controllers with non-fused disconnect switch and motor

circuit protector breaker in common enclosure.

- B. Magnetic Motor Controllers: NEMA ICS 2, ac general-purpose Class A magnetic controller for induction motors rated in horsepower as specified in paragraph 2.03A.
- C. Options and Features as specified in paragraph 2.03B.
- D. Manufacturer: Cutler-Hammer Freedom Series or approved equal.

2.05 COMBINATION CONTACTOR CONTROLLERS

- A. Description: Combined contactor controller with thermal magnetic breaker disconnect, control power transformer and hand-off-auto selector in NEMA Type 1 enclosure.
- B. Contactor: 30 Ampere size, 3 pole, 600 Volt, electrically held contactor with 120 volt coil.
- C. Manufacturer: Cutler-Hammer ELC03 Series or approved equal.

PART 3 - EXECUTION

3.01 FACTORY TESTING

- A. Standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.
- B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.02 FIELD QUALITY CONTROL

- A. Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and start-up of the equipment specified under this section. The manufacturer's representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained herein.
- B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative.
- C. Inspection and final adjustments
- D. Operational and functional checks of starters and spare parts.

- E. The Contractor shall provide three (3) copies of the manufacturer's field startup report.

3.03 MANUFACTURER'S CERTIFICATION

- A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.
- B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

END OF SECTION

SECTION 16482

MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 DESCRIPTION

This section includes the following:

- A. Requirements for a motor control center(s) (MCC) and all required control devices as shown on the drawings and specified to be part of the MCC equipment.
- B. Requirement for modifications to existing motor control center(s) (MCC) with all associated control devices as shown on the drawings and/or specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 16473 – Surge Protective Devices
- B. Section 16481 – Motor Starters
- C. Section 16483 – Variable Frequency Drives (1 - 60 HP)
- D. Section 16484 – Variable Frequency Drives (75 HP and Larger)
- E. Section 16900 – Electrical Controls and Instrumentation

1.02 SUBMITTALS

- A. Consult Section 16010 - Submittals, for shop drawing requirements on all materials specified in this section.
- B. The submittal is to include the following information:
 - 1. Master drawing index
 - 2. Front view elevation
 - 3. Floor plan
 - 4. Top view
 - 5. Unit wiring diagrams
 - 6. Nameplate schedule

7. Starter and component schedule
8. Conduit entry/exit locations
9. Assembly ratings including:
 - a. Short-circuit rating
 - b. Voltage
 - c. Continuous current
10. Major component ratings including:
 - a. Voltage
 - b. Continuous current
 - c. Interrupting ratings
11. Cable terminal sizes
12. Product data sheets

1.03 REGULATORY REQUIREMENTS

The MCC must conform to Underwriter's Laboratory (UL) 845, current revision, CSA, EEMAC, NEMA ICS-2 and the latest version of the National Electrical Code. The MCC must be manufactured in an ISO 9001 or 9002 certified facility.

1.04 PACKING/SHIPPING

The MCC shall be separated into shipping blocks no more than three vertical sections each. Shipping blocks shall be shipped on their sides to permit easier handling at the jobsite. Each shipping block shall include a removable lifting angle, which will allow an easy means of attaching an overhead crane or other suitable lifting equipment.

1.05 STORAGE

If the MCC cannot be placed into service reasonably soon after receipt, store it in a clean, dry and ventilated building free from temperature extremes. Acceptable storage temperatures are from 0°C (32°F) to 40°C (104°F).

1.06 OPERATION AND MAINTENANCE MANUALS

Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and

renewal parts lists where applicable, for the complete assembly and each major component.

1.07 WARRANTY

The MCC shall be warranted to be free from defects in materials and workmanship for a period of one (1) year from the date of Substantial Completion Acceptance.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton/Cutler-Hammer Freedom 2100 Series

2.02 RATINGS

- A. The Motor Control Center(s) shall be 600-volt class suitable for 480 Volt, 3 - phase, 4-wire, 60 Hz. System. A neutral bus is to be provided in the main incoming section. MCC buss way shall consist of three (3) phase distribution.

2.03 MATERIALS

- A. Steel material shall comply with UL 845 and CSA requirements.
- B. Each MCC shall consist of one or more vertical sections of heavy gauge steel bolted together to form a rigid, freestanding assembly. A removable 7-gauge structural steel lifting angle shall be mounted in full width of the MCC lineup at the top. Removable 7 gauge bottom channel sills shall be mounted underneath front and rear of the vertical sections extending the full width of the lineup. Vertical sections made of welded side-frame assembly formed from a minimum of 12-gauge steel. Internal reinforcement structural parts shall be of 11-gauge steel to provide a strong, rigid assembly. The entire assembly shall be constructed and packaged to withstand all stresses included in transit and during installation.

2.04 MCC FINISH

- A. All steel parts shall be provided with UL and CSA listed acrylic/alkyd baked enamel paint finish, except plated parts used for ground connections. All painted parts shall undergo a multi-stage treatment process, followed by the finishing paint coat.
- B. Pre-treatment shall include:
 - 1. Hot alkaline cleaner to remove grease and oil.
 - 2. Iron phosphate treatment to improve adhesion and corrosion resistance.

- C. The paint shall be applied using an electro-deposition process to ensure a uniform paint coat with high adhesion.
- D. The standard paint finish shall be tested to UL 50 per ASTM B117 (5% ASTM Salt Spray) with no greater than 0.125 in (3 mm) loss of paint from a scrubbed line.
- E. Paint color shall be #49 medium light gray per ANSI standard Z55.1-967 (60-70 gloss) on all surfaces unless specified otherwise. Control station plates and escutcheon plates shall be painted a contrasting gray. All unit interior saddles shall be painted white for better visibility inside the unit.

2.05 STRUCTURES

- A. Structures shall be totally enclosed, dead-front, freestanding assemblies. Structures shall be capable of being bolted together to form a single assembly.
- B. The overall height of the MCC shall not exceed 90 in (not including base channel). Base channels, of 1.5 in (38 mm) in height, shall be removable. The total width of one section shall be 20 in (508 mm); (widths of 25 in (630 mm), 30 in (760 mm), and 35 in (890 mm) can be used for larger devices.
- C. Structures shall be NEMA/EEMAC Type 1A (gasketed general purpose).
- D. Each 20 in wide standard section shall have all the necessary hardware and bussing for modular plug-in units to be added and moved around. All unused space shall be covered by hinge blank doors and equipped to accept future units. Manual bus shutters shall cover vertical bus openings.
- E. Each section shall include a top plate (single piece or two piece). Top plates shall be removable for ease in cutting conduit entry openings.

2.05 WIREWAYS

- A. Structures shall contain a minimum 9 in (305 mm) high horizontal wireway at the top of each section and a minimum 9 in (152 mm) high horizontal wireway at the bottom of each section. These wireways shall run the full length of MCC to allow room for power and control cable to connect between units in different sections.
- B. A full-depth vertical wireway shall be provided in each MCC section that accepts modular plug-in units. The vertical wireway shall connect with both top and bottom horizontal wireway and shall be isolated from unit interiors by a full height barrier. The vertical wireway shall be 4 in (102 mm) wide minimum with a separate hinged door. Access to the wireways shall not require opening control

unit doors. Structures that house a single, full section control unit are not required to have vertical wireways. Those control units must open directly into the MCC horizontal wireways.

2.06 BARRIERS

- A. All power bussing and splice connections shall be isolated from the unit compartments and the wireways. The horizontal bus shall be mounted onto a glass filled polyester support assembly that braces the bus against the forces generated during a short circuit. The horizontal bus shall be isolated from the top horizontal wireway by a two-piece grounded steel barrier. This barrier shall be removable to allow access to the bus and connections for maintenance.
- B. The vertical bus shall be housed in a molded glass-filled polyester support that provides bus insulation and braces the bus against the forces generated during a short circuit. These supports shall have openings every 3 in (75 mm) for unit stab-on connections. Each opening shall be provided with a manual shutter to close off the stab opening. These shutters shall be attached to the structure so that when they are removed (to allow a slab connection) they are retained in the structure and are readily accessible for use should a plug-in unit be removed from the MCC.
- C. Barriers shall be provided in the vertical structure and unit designs to prevent the contact of any energized bus or terminal by a fishtape inserted through the conduit or wireway areas.

2.07 BUSSING

- A. All bussing and connectors shall be tin-plated copper.
- B. The main horizontal bus shall be continuous rated for the ampere capacity indicated for the full length of the MCC. Bus rating shall be based on 65°C maximum temperature rise in a 40°C ambient. Provision shall be provided for splicing additional sections on to either end of the MCC.
- C. The horizontal bus splice shall be pre-assembled into a captive bus stack. This bus stack is installed into the end of the MCC power bus to allow the installation of additional sections. The main bus splice shall utilize four bolts, two on each side of the bus split, for each phase. Additional bolts must not be required when splicing higher amperage bus. The splice bolts shall secure to captive nuts installed on the back of the splice assembly. It shall be possible to maintain any bus connection with a single tool.
- D. Each section that accepts plug-in units shall be provided with a vertical bus for distributing power from the main bus to the individual plug-in starter units. This bus shall be of the same material and plating as the main bus, and shall be rated at

300 A continuous. The vertical bus shall be connected directly to the horizontal bus stack without the use of risers or other intervening connectors. It shall be possible to maintain the vertical to horizontal bus connection with a single tool. "Nut and bolt" bus connections to the power bus shall not be permitted. When a back-to-back unit arrangement is utilized, separate vertical bus shall be provided for both the front and rear units.

- E. A tin plated copper ground bus shall be provided that runs the entire length of the MCC. The ground bus shall be 0.25 in (6.0 mm) x 1.0 in (25 mm) and be rated for 300 amps. A compression lug shall be provided in the MCC for a 4/0-250 kcmil ground cable. The ground bus shall be provided with (6) 0.38 in (10 mm) holes for each vertical section to accept customer-supplied ground lugs for any loads requiring a ground conductor.
- F. Each vertical section shall have a copper vertical ground bus that it is connected to the horizontal ground bus. This vertical ground bus shall be installed so that the plug-in units engage the ground bus prior to engagement of the power stabs and shall disengage only after the power stabs are disconnected upon removal of the plug-in unit.
- G. The power bus system shall be braced for a short circuit capacity of 42KAIC minimum as standard.

2.08 TYPICAL UNIT CONSTRUCTION

- A. Units with circuit breaker or motor circuit protector type disconnects through 250 A frame, shall connect to the vertical bus through a spring reinforced stab-on connector. Units with larger disconnects shall be connected directly to the main horizontal bus with appropriately sized riser bus. Stabs on all plug-in units shall be solidly bussed to the unit disconnect. Cabled stab assemblies are not permitted.
- B. All conducting parts on the line side of the unit disconnect shall be shrouded by a suitable insulating material to reduce the possibility of accidental contact with those parts.
- C. Unit mounting shelves shall include hanger brackets to support the unit weight during installation and removal. All plug-on units shall use a twin-handle camming lever located at the top of the bucket to rack in and out the plug-on unit. The cam lever shall work in conjunction with the hanger brackets to ensure positive stab alignment.
- D. A cast metal handle operator must be provided on each disconnect. With the unit stabs engaged into the vertical phase bus and the unit door closed, the handle mechanism shall allow complete ON/OFF control of the unit disconnect with clear indication of the disconnects status. All circuit breaker and motor circuit protector

operators shall include a separate TRIPPED position to clearly indicate a trip condition. It shall be possible to reset a tripped condition without opening the control unit door.

- E. A mechanical interlock shall prevent the operator from opening the unit door when the disconnect is in the ON position. Another mechanical interlock shall prevent the operator from placing the disconnect in the ON position while the unit door is open. It shall be possible for authorized personnel to defeat these interlocks.
- F. A non-defeatable interlock shall be provided between the handle operator and the cam lever to prevent installing or removing a plug-on unit unless the disconnect is in the OFF position.
- G. The plug-in unit shall have a grounded stab-on connector that engages the vertical ground bus prior to, and releases after, the power bus stab-on connectors.
- H. Provisions shall be provided for locking all disconnects in the OFF position with up to three padlocks.
- I. Handle mechanism shall be located on the left side to encourage operators to stand to the left of the unit being switched.
- J. Unit construction shall combine with the vertical wireway isolation barrier to provide a fully compartmentalized design.

2.09 WIRING/TERMINATIONS

- A. Terminal Blocks:
 - 1. All starter units shall be provided with unit control terminal blocks (Type B).
 - 2. Terminal blocks shall be the pull-apart type 600 Volt and rated at 25 Amps. All current carrying parts shall be tin plated. Terminals shall be accessible from inside the unit when the unit door is opened. Terminal blocks shall be DIN rail mounted with the stationary portion of the block secured to the unit bottom plate. The stationary portion shall be used for factory connections and shall remain attached to the unit when removed. The terminals used for field connections shall face forward so they can be wired without removing the unit or any of its components.

2.10 COMPONENTS

- A. Combination Starters:

1. Combination starters shall conform to requirements specified in Section 16481 and with interrupting rating matching MCC requirements.
2. The disconnect device within the starter compartment shall be a circuit breaker in size selected by the manufacturers for motor being served.
3. Operator and indicator features shall be provided with associated wiring for control on drawings and/or specified herein.

B. Variable Frequency Drives

1. Combination variable frequency drives shall conform to requirements specified in Section 16483 and 16484 with interrupting rating matching MCC requirements.
2. The disconnect device within the drive compartment shall be a circuit breaker in size selected by the manufacturers for motor being served.
3. Operator and indicator features shall be provided with associated wiring for control on drawings and/or specified herein.
4. Each VFD shall be provided with a 3% rated line reactor and a motor protective filter, each in individual MCC compartments.

D. Branch Feeder Units:

1. Molded case circuit breakers shall be constructed in accordance with the following standards:
 - a. UL 489
 - b. NEMA AB1
 - c. Federal Specification W-C 375B/GEN
 - d. CSA 22.2, no. 5-M1986
 - e. IEC 157-1
 - f. BS4752
2. Circuit breaker shall be constructed using glass reinforced insulating material providing superior dielectric strength. Current carrying components shall be completely isolated from the handle and the necessary mounting area.

3. Each circuit breaker shall have common tripping of all poles and shall be trip-free.
4. The circuit breaker shall be quick-make, quick-break with an overcenter toggle operating mechanism. Breakers shall not be able to be tested into a neutral position.
5. Breaker handle and faceplate shall indicate rated ampacity. Breaker faceplate shall indicate UL and IEC certification standards with applicable voltage systems and corresponding AIC ratings.
6. Circuit breaker shall be factory sealed and shall have a data code on the face of the circuit breaker. Poles shall be labeled with respective phase designations.
7. Circuit breaker escutcheon shall have International I/O markings, in addition to standard ON/OFF markings.
8. Each circuit breaker shall be equipped with a push-to-trip button to mechanically operate the circuit breaker tripping mechanism.
9. Interrupting rating shall match MCC requirements.
10. Trip System:
 - a. Each circuit breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole.
 - b. All circuit breakers shall have factory sealed thermal trip elements. The thermal trip system shall be true RMS sensing and thermally responsive to protect circuit conductor(s) in a 40°C ambient temperature. Thermal elements shall be ambient compensating above 40°C to provide consistent protection to circuit conductors.
 - c. Circuit breakers with frame sizes greater than 100 Amps shall have variable magnetic trip elements, which are set by a single adjustment to simultaneously adjust the instantaneous trip point in all poles.

10. Terminations:

- a. All lugs shall be UL listed to accept solid and/or stranded copper conductors only. Lugs shall be suitable for 90°C rated wire, sized according to the temperature rating in the NEC. Lug body shall be bolted in place; snap-in designs are not acceptable.
- b. All circuit breakers shall be UL listed to accept field installable/removable compression type lugs.

E. Six Inch Unit Construction:

1. Units with circuit breaker disconnects through 100 Amp frame shall connect to the vertical through a spring reinforced stab-on connector. Stabs on all plug-on units shall be cable connected to the unit disconnect. Six-inch units with breakers shall be rated for 65KAIC at 480 volts.
2. All conducting parts on the line side of the unit disconnect shall be shrouded by a suitable insulating material.
3. Unit mounting shelves shall include hanger brackets to support the unit weight during installation and removal. All six-inch plug-on units shall be installable without the assistance of a camming device.

F. Nameplates:

1. Shall be engraved phenolic nameplates for each MCC and unit compartment. Nameplates shall be black letters on white background, measuring a minimum of 1.5 in H x 4 in W.

PART 3 EXECUTION

3.01 LOCATION

- A. Motor control centers shall be located on a concrete housekeeping pad where indicated.
- B. The MCCs shall be assembled in the factory on a smooth level surface so that all sections are properly aligned. A similar smooth and level surface shall be provided for installation. Size of the shipping sections shall be coordinated by the contractor for access limitations in installing the MCCs.

3.02 ADJUSTING

- A. The supplier shall provide a coordination study to determine trip, time delay, and instantaneous settings.
- B. Adjust circuit breaker trip and time delay settings and motor circuit protector instantaneous settings to values provided in the coordination study.

3.03 CLEANING

- A. Touch up scratched or marred surfaces to match original finish.

3.04 TRAINING

- A. The Contractor shall provide a training session for up to five (5) owner's representatives for two (2) normal workdays at a job site location determined by the owner.
- B. The training representative shall be conducted by a manufacturer's qualified representative.
- C. The training program shall consist of the following:
 - 1. Instructions on the proper maintenance and operations of the equipment
 - 2. Instructions on adjusting set points and parameters of electronic devices.

END OF SECTION

SECTION 16483

VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This section provides specification requirements for enclosed three-phase variable frequency drive controllers, herein referred to as AC Drives for use with NEMA[®] B design AC motors.
- B. The AC Drive manufacturer shall furnish, field test, adjust and certify all installed AC Drives for satisfactory operation.
- C. Any exceptions/deviations to this specification shall be indicated in writing and submitted with the quotation.

1.02 REFERENCES

- A. ANSI[®]/NFPA[®] 70 - National Electrical Code[®] (NEC[®])
- B. ANSI C84.1 - Voltages Tolerances for North America
- C. NEMA ICS 6 - Industrial Control and Systems Enclosures
- D. NEMA ICS, Part 4 Overload Relays
- E. NEMA 250 Enclosures for Electrical Equipment
- F. NEMA ICS 2-321 - Electrical Interlocks
- G. NEMA ICS7 - Industrial Control and Systems Adjustable Speed Drives
- H. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection Installation and Operation of Adjustable Speed Drives
- I. UL[®] 50 - UL Standard for Safety Enclosures for Electrical Equipment
- J. UL 508 - UL Standard for Safety Industrial Control Equipment

- K. UL 508C - UL Standard for Safety Power Conversion Equipment
- L. UL 991 - UL Standard for Safety Tests for Safety Related Controls employing Solid State Devices
- M. OSHA® 1910.95 - AC Drive Controller Acoustical Noise
- N. The Variable frequency drives and all components shall be designed, manufactured and tested in accordance with the latest applicable standards.
 - 1. Institute of Electrical and Electronic Engineers (IEEE)
 - a. IEEE 519-1992: Guide for harmonic content and control
 - 2. Underwriters Laboratories (UL508C: Power Conversion Equipment)
 - a. UL
 - 3. National Electrical Manufacturer's Association (NEMA)
 - a. ICS 7.0: Industrial Controls & Systems for VFD.

1.03 SUBMITTALS

- A. Consult Section 16010 - Submittals, for shop drawing requirements.

1.04 WARRANTY

- A. 12-month parts warranty shall be provided on materials, labor, workmanship and travel from the date of Substantial Completion Acceptance.

1.05 QUALITY ASSURANCE

- A. The manufacturer of the AC Drive shall be a certified ISO 9001 facility.
- B. The AC Drive and all associated optional equipment shall be UL Listed according to UL508C Power Conversion Equipment. A UL label shall be attached inside each enclosure as verification.
- C. The AC Drive shall be designed constructed and tested in accordance with NEMA, NEC, VDE, and IEC standards.

- D. Every power converter shall be tested with an actual ac induction motor, 100% load and temperature cycled within an environmental chamber at 104 °F. Documentation shall be furnished to verify successful completion at the request of the engineer.
- E. All Drive door mounted pilot devices shall be tested to verify successful operation. Documentation shall be furnished upon written request of the engineer.
- F. The AC Drive shall be submitted to a hi-pot test with all enclosed devices mounted and wired, prior to shipment.
- G. The supplier of the assembly shall be the manufacturer of the electromechanical power components used within the assembly.

PART 2 PRODUCT

2.01 MANUFACTURER: Cutler-Hammer Series SPX 9000 Series 6 Pulse Unit with Line Reactors.

2.02 VARIABLE FREQUENCY DRIVES

- A. Variable frequency drives, Constant Torque (CT) shall have the following features:
 1. The VFD shall be rated for 480 VAC. The VFD shall provide microprocessor-based control for three-phase induction motors. The controller's full load output current rating shall be based on 50° C ambient.
 2. The VFD shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation.
 3. The VFD shall have efficiency at full load and speed that exceeds 95% for VFD below 15-HP and 97% for drives 15-HP and above. The efficiency shall exceed 90% at 50% speed and load.
 4. The VFD shall maintain the line side displacement power factor at no less than 0.96, regardless of speed and load.
 5. The VFD shall have a one (1) minute overload current rating of 150% and a two (2) second overload current rating of 250%.
 6. The VFD shall be capable of operating of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the VFD.
 7. The VFD shall have an integral EMI/RFI filter as standard.

8. The VFD shall limit harmonic distortion reflected onto the utility system to a voltage and current level as defined by IEEE 519 for general systems applications, by utilizing the standard 3% nominal impedance integral AC three-phase line reactor.
9. Harmonic calculations shall be performed based on the kVA capacity, X/R ratio and the impedance of the utility transformer feeding the installation, and the total system load. The calculations shall be made with the point of common coupling being the point where the utility feeds multiple customers.
10. Total harmonic distortion shall be calculated under worst-case conditions in accordance with the procedure outlined in IEEE standard 519-1992. Copies of these calculations are to be submitted. The contractor shall provide any needed information to the VFD supplier weeks prior to requiring harmonic calculations.
11. The system containing the AFD shall comply with the 5% level of total harmonic distortion of line voltage and the line current limits as defined in IEEE 519-1992. If the system cannot meet the harmonic levels with the with the AFD provided with the standard input line reactor or optional input isolation transformer, the AFD manufacturer shall supply an eighteen pulse, multiple bridge rectifier AC to DC conversion section with phase shifting transformer for all drives 50-HP and above. This eighteen-pulse rectifier converter shall result in a multiple pulse current waveform that will more nearly approximate a true sine-wave to reduce voltage harmonic content on the utility line. The phase shifting transformer shall be of a single winding type to optimize its KVA rating and harmonic cancellation capability. Harmonic filters are not acceptable for drives 50-HP and above.
12. The VFD shall be able to start into a spinning motor. The VFD shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the VFD shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.
13. Standard operating conditions shall be:
 - a. Incoming Power: Three-phase, 480 Vac (+10% to -15%) and 60 Hz (+/-5 Hz) power to a fixed potential DC bus level.
 - b. Frequency stability of +/-0.05% for 24 hours with voltage regulation of +/-1% of maximum rated output voltage.
 - c. Speed regulation of +/- 0.5% of base speed.
 - d. Load inertia dependant carryover (ride-through) during utility loss.
 - e. Insensitive to input line rotation.

- f. Humidity: 0 to 95% (non-condensing and non-corrosive).
- g. Altitude: 0 to 3,300 feet (1000 meters) above sea level.
- h. Ambient Temperature: -10 to 50 °C.
- i. Storage Temperature: -40 to 60 °C.

14. Control Functions

- a. Frequently accessed VFD programmable parameters shall be adjustable from a digital operator keypad located on the front of the VFD. The VFD shall have a 3 line alphanumeric programmable display with status indicators. Keypads must use plain English words for parameters, status, and diagnostic messages. Keypads that are difficult to read or understand are not acceptable, and particularly those that use alphanumeric code and tables. Keypads shall be adjustable for contrast with large characters easily visible in normal ambient light.
- b. The keypad shall include a Local/Remote pushbutton selection. Both start/stop source and speed reference shall be independently programmable for Keypad, Remote I/O, or Field Bus.
- c. The keypad shall have copy / paste capability.
- d. Upon initial power up of the VFD, the keypad shall display a start up guide that will sequence all the necessary parameter adjustments for general start up.
- e. Standard advanced programming and trouble-shooting functions shall be available by using a personal computer's RS-232 port and Windows™ based software. In addition the software shall permit control and monitoring via the VFD RS232 port. The manufacturer shall supply a diskette with the required software. An easily understood instruction manual and software help screens shall also be provided. The computer software shall be used for modifying the drive setup and reviewing diagnostic and trend information as outlined in this paragraph through paragraph 14.
- f. The operator shall be able to scroll through the keypad menu to choose between the following:
 - 1. Monitor
 - 2. Operate
 - 3. Parameter setup
 - 4. Actual parameter values

5. Active faults
 6. Fault history
 7. LCD contrast adjustment
 8. Information to indicate the standard software and optional features software loaded.
- g. The following setups and adjustments, at a minimum, are to be provided:
1. Start command from keypad, remote or communications port
 2. Speed command from keypad, remote or communications port
 3. Motor direction selection
 4. Maximum and minimum speed limits
 5. Acceleration and deceleration times, two settable ranges
 6. Critical (skip) frequency avoidance
 7. Torque limit
 8. Multiple attempt restart function
 9. Multiple preset speeds adjustment
 10. Catch a spinning motor start or normal start selection
 11. Programmable analog output
 12. DC brake current magnitude and time
 13. PID process controller
14. The VFD shall have the following system interfaces:
- a. Inputs – A minimum of six (6) programmable digital inputs, two (2) analog inputs and serial communications interface shall be provided with the following:
 1. Remote manual/auto
 2. Remote start/stop
 3. Remote forward/reverse
 4. Remote preset speeds
 5. Remote external trip

6. Remote fault reset
 7. Process control speed reference interface, 4-20mA DC
 8. Potentiometer and 1-10VDC speed reference interface
 9. RS-232 programming and operation interface port
 10. Serial communications port
- B. Outputs – A minimum of two (2) discrete programmable digital outputs, one (1) programmable open collector output, and one (1) programmable analog output shall be provided, with the following.
1. Programmable relay outputs with one (1) set of Form C contacts for each, selectable with the following:
 - a. Fault
 - b. Run
 - c. Ready
 - d. Reversed
 - e. Jogging
 - f. At speed
 - g. Torque Limit Supervision
 - h. Motor rotation direction opposite of commanded
 - i. Over-temperature
 2. Programmable open collector output with available 24VDC power supply and selectable with the following:
 - a. Fault
 - b. Run
 - c. Ready
 - d. Reversed
 - e. Jogging
 - f. At speed
 - g. Torque Limit Supervision
 - h. Motor rotation direction opposite of commanded

- i. Over-temperature
3. Programmable analog output signal, selectable with the following:
 - a. Motor current
 - b. Output frequency
 - c. Frequency reference
 - d. Motor speed
 - e. Motor torque
 - f. Motor power
 - g. Motor voltage
 - h. DC-bus voltage
 - i. AI1 (Analog Input 1)
 - j. AI2 (Analog Input 2)
 - k. PT100 temperature
 - l. FB digital input 4 (Field Bus Input)
4. Monitoring and Displays
 - a. The VFD display shall be a LCD type capable of displaying three (3) lines of text and the following thirteen (13) status indicators:
 1. Run
 2. Forward
 3. Reverse
 4. Stop
 5. Ready
 6. Alarm
 7. Fault
 8. Input/Output (I/O) terminal
 9. Keypad
 10. Bus/Communication
 11. Local (LED)

12. Remote (LED)
13. Fault (LED)
14. The VFD keypad shall be capable of displaying the following monitoring functions:
 - a. Output frequency
 - b. Frequency reference
 - c. Motor speed
 - d. Motor current
 - e. Motor torque
 - f. Motor power
 - g. Motor voltage
 - h. DC-bus voltage
 - i. Unit temperature
 - j. Calculated motor temperature
 - k. Voltage level of analog input
 - l. Current level of analog input
 - m. Digital inputs status
 - n. Digital and relay outputs status
 - o. Analog Input

5. Protective Functions

- a. The VFD shall include the following protective features:
 1. Over-current
 2. Over-voltage
 3. Inverter fault
 4. Under-voltage
 5. Input phase loss
 6. Output phase loss
 7. Under-temperature

8. Over-temperature
 9. Motor stalled
 10. Motor over-temperature
 11. Motor under-load
 12. Logic voltage failure
 13. Microprocessor failure
- b. The VFD shall provide ground fault protection during power-up, starting, and running. VFD with no ground fault protection during running is not acceptable.
6. Diagnostic Features
- a. Fault History
 1. Record and log faults
 2. Indicate the most recent first, and store up to 30 faults
7. Additional features to be included in the VFD:
- a. HMCP or thermal magnetic breaker to provide a disconnect means. Operating handle shall protrude through the door. The disconnect shall not be mounted on the door. The handle position shall indicate ON, OFF, and TRIPPED condition. The handle shall have provisions for padlocking in the OFF position with at least three (3) padlocks. Interlocks shall prevent unauthorized opening or closing of the VFD door with the disconnect handle in the ON position. Qualified maintenance personnel can defeat door handle interlock.
 - b. Laminated plastic or steel nameplate engraved with user's identifying name or number for oversize enclosures.
 - c. 120 VAC control to allow VFD to interface with remote dry contacts.
 - d. A 3% line reactor shall be installed at the VFD output to reduce dv/dt levels and the resultant peak voltage overshoots at the motor terminals.
8. Enclosure
- a. The VFD enclosure shall be NEMA 12. The VFD shall have complete front accessibility with easily removable assemblies.
9. Spare Parts
- a. The main logic board, keypad and power supply board shall be supplied as spares, one for each different part number supplied.

10. The VFD manufacturer shall maintain, as part of a national network, engineering service facilities within 100 miles of project to provide start-up service, emergency service calls, repair work, service contracts, maintenance and training of customer personnel.
11. All VFD's shall be individually mounted.
12. Power for cooling shall be provided internal to the AC Drive unit by use of a control power transformer.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify that the location is ready to receive work and the dimensions are as indicated.
- B. Do not install AC Drive equipment until the building environment can be maintained within the service conditions required by the manufacturer.

3.02 FACTORY TESTING

- A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.
 1. All printed circuit boards shall be functionally tested via automatic test equipment prior to unit installation.
 2. After all tests have been performed; each VFD shall undergo a burn-in test. The drive shall be burned in at 100% inductive or motor load without an unscheduled shutdown.
 3. After the burn-in cycle is complete, each VFD shall be put through a motor load test before inspection and shipping.
- B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.03 PROTECTION - Before and during the installation, the ac drive equipment shall be protected from site contaminants.

3.03 INSTALLATION

- A. Installation shall comply with manufacturer's instructions, drawings and recommendations.

- B. The AC Drive manufacturer shall provide a factory certified technical representative to supervise the contractor's installation, testing and start-up of the AC Drive(s) furnished under this specification for a maximum total of 2 days.

3.04 FIELD QUALITY CONTROL

- A. Provide the services of a qualified manufacturer's employed Field Service Engineer to assist the Contractor in installation and start-up of the equipment specified under this section. Field Service personnel shall be factory trained with periodic updates and have experience with the same model of VFD on the job site. Sales representatives will not be acceptable to perform this work. The manufacturer's service representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, installation as specified in manufacturer's installation instructions, wiring, application dependant adjustments, and verification of proper VFD operation.
- B. The Contractor under the technical direction of the manufacturer's service representative shall perform the following minimum work.
 - 1. Inspection and final adjustments.
 - 2. Operational and functional checks of VFD and spare parts.
 - 3. The contractor shall certify that he has read the drive manufacturer's installation instructions and has installed the VFD in accordance with those instructions.
- C. The Contractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made.

3.05 TRAINING

- A. An on-site training course of 2 training days shall be provided by a representative of the AC Drive manufacturer plant and/or maintenance personnel and quoted as a separate line item.
- B. The training program shall consist of the following:
 - 1. Instructions on the proper operation of the equipment.
 - 2. Instructions on the proper maintenance of the equipment.

END OF SECTION

SECTION 16483

VARIABLE FREQUENCY DRIVES (75 HP & LARGER)

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This section provides specification requirements for enclosed three-phase variable frequency drive controllers, herein referred to as AC Drives for use with NEMA[®] B design AC motors.
- B. The AC Drive manufacturer shall furnish, field test, adjust and certify all installed AC Drives for satisfactory operation.
- C. Any exceptions/deviations to this specification shall be indicated in writing and submitted with the quotation.

1.02 REFERENCES

- A. ANSI[®]/NFPA[®] 70 - National Electrical Code[®] (NEC[®])
- B. ANSI C84.1 - Voltages Tolerances for North America
- C. NEMA ICS 6 - Industrial Control and Systems Enclosures
- D. NEMA ICS, Part 4 Overload Relays
- E. NEMA 250 Enclosures for Electrical Equipment
- F. NEMA ICS 2-321 - Electrical Interlocks
- G. NEMA ICS7 - Industrial Control and Systems Adjustable Speed Drives
- H. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection Installation and Operation of Adjustable Speed Drives
- I. UL[®] 50 - UL Standard for Safety Enclosures for Electrical Equipment
- J. UL 508 - UL Standard for Safety Industrial Control Equipment

- K. UL 508C - UL Standard for Safety Power Conversion Equipment
- L. UL 991 - UL Standard for Safety Tests for Safety Related Controls employing Solid State Devices
- M. OSHA[®] 1910.95 - AC Drive Controller Acoustical Noise
- N. The Variable frequency drives and all components shall be designed, manufactured and tested in accordance with the latest applicable standards.
 - 1. Institute of Electrical and Electronic Engineers (IEEE)
 - a. IEEE 519-1992: Guide for harmonic content and control
 - 2. Underwriters Laboratories (UL508C: Power Conversion Equipment)
 - a. UL
 - 3. National Electrical Manufacturer's Association (NEMA)
 - a. ICS 7.0: Industrial Controls & Systems for VFD.

1.03 SUBMITTALS

- A. Consult Section 16010 - Submittals, for shop drawing requirements.

1.04 WARRANTY

- A. 12-month parts warranty shall be provided on materials, labor, workmanship and travel from the date of Substantial Completion Acceptance.

1.05 QUALITY ASSURANCE

- A. The manufacturer of the AC Drive shall be a certified ISO 9001 facility.
- B. The AC Drive and all associated optional equipment shall be UL Listed according to UL508C Power Conversion Equipment. A UL label shall be attached inside each enclosure as verification.
- C. The AC Drive shall be designed constructed and tested in accordance with NEMA, NEC, VDE, and IEC standards.

- D. Every power converter shall be tested with an actual ac induction motor, 100% load and temperature cycled within an environmental chamber at 104 °F. Documentation shall be furnished to verify successful completion at the request of the engineer.
- E. All Drive door mounted pilot devices shall be tested to verify successful operation. Documentation shall be furnished upon written request of the engineer.
- F. The AC Drive shall be submitted to a hi-pot test with all enclosed devices mounted and wired, prior to shipment.
- G. The supplier of the assembly shall be the manufacturer of the electromechanical power components used within the assembly.

PART 2 PRODUCT

2.01 MANUFACTURERS

- A. Variable Frequency Drives shall be by the same manufacturer as that selected for the Motor Control Center.
 1. Cutler-Hammer Series: CVX 9000 Series, 18 Pulse Convertor.
 2. Toshiba P9

2.02 VARIABLE FREQUENCY DRIVES

- A. Variable frequency drives 1 through 2000 Horsepower (HP), Constant Torque (CT) shall have the following features:
 1. The VFD shall be rated for 480 VAC. The VFD shall provide microprocessor-based control for three-phase induction motors. The controller's full load output current rating shall be based on 50° C ambient.
 2. The VFD shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation.
 3. The VFD shall have efficiency at full load and speed that exceeds 95% for VFD below 15-HP and 97% for drives 15-HP and above. The efficiency shall exceed 90% at 50% speed and load.
 4. The VFD shall maintain the line side displacement power factor at no less than 0.96, regardless of speed and load.

5. The VFD shall have a one (1) minute overload current rating of 150% and a two (2) second overload current rating of 250%.
6. The VFD shall be capable of operating of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the VFD.
7. The VFD shall have an integral EMI/RFI filter as standard.
8. The VFD shall limit harmonic distortion reflected onto the utility system to a voltage and current level as defined by IEEE 519 for general systems applications, by utilizing the standard 3% nominal impedance integral AC three-phase line reactor.
9. Harmonic calculations shall be performed based on the kVA capacity, X/R ratio and the impedance of the utility transformer feeding the installation, and the total system load. The calculations shall be made with the point of common coupling being the point where the utility feeds multiple customers.
10. Total harmonic distortion shall be calculated under worst-case conditions in accordance with the procedure outlined in IEEE standard 519-1992. Copies of these calculations are to be submitted. The contractor shall provide any needed information to the VFD supplier weeks prior to requiring harmonic calculations.
11. The VFD shall be an eighteen pulse, multiple bridge rectifier AC to DC conversion section with phase shifting transformer. This eighteen-pulse rectifier converter shall result in a multiple pulse current waveform that will more nearly approximate a true sine-wave to reduce voltage harmonic content on the utility line. The phase shifting transformer shall be of a single winding type to optimize its KVA rating and harmonic cancellation capability.
12. The VFD shall be able to start into a spinning motor. The VFD shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the VFD shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.
13. Standard operating conditions shall be:
 - a. Incoming Power: Three-phase, 480 Vac (+10% to -15%) and 60 Hz (+/-5 Hz) power to a fixed potential DC bus level.
 - b. Frequency stability of +/-0.05% for 24 hours with voltage regulation of +/-1% of maximum rated output voltage.
 - c. Speed regulation of +/- 0.5% of base speed.
 - d. Load inertia dependant carryover (ride-through) during utility loss.

- e. Insensitive to input line rotation.
- f. Humidity: 0 to 95% (non-condensing and non-corrosive).
- g. Altitude: 0 to 3,300 feet (1000 meters) above sea level.
- h. Ambient Temperature: -10 to 50 °C.
- i. Storage Temperature: -40 to 60 °C.

14. Control Functions

- a. Frequently accessed VFD programmable parameters shall be adjustable from a digital operator keypad located on the front of the VFD. The VFD shall have a 3 line alphanumeric programmable display with status indicators. Keypads must use plain English words for parameters, status, and diagnostic messages. Keypads that are difficult to read or understand are not acceptable, and particularly those that use alphanumeric code and tables. Keypads shall be adjustable for contrast with large characters easily visible in normal ambient light.
- b. The keypad shall include a Local/Remote pushbutton selection. Both start/stop source and speed reference shall be independently programmable for Keypad, Remote I/O, or Field Bus.
- c. The keypad shall have copy / paste capability.
- d. Upon initial power up of the VFD, the keypad shall display a start up guide that will sequence all the necessary parameter adjustments for general start up.
- e. Standard advanced programming and trouble-shooting functions shall be available by using a personal computer's RS-232 port and Windows™ based software. In addition the software shall permit control and monitoring via the VFD RS232 port. The manufacturer shall supply a diskette with the required software. An easily understood instruction manual and software help screens shall also be provided. The computer software shall be used for modifying the drive setup and reviewing diagnostic and trend information as outlined in this paragraph through paragraph 14.
- f. The operator shall be able to scroll through the keypad menu to choose between the following:
 - 1. Monitor
 - 2. Operate
 - 3. Parameter setup

4. Actual parameter values
 5. Active faults
 6. Fault history
 7. LCD contrast adjustment
 8. Information to indicate the standard software and optional features software loaded.
- g. The following setups and adjustments, at a minimum, are to be provided:
1. Start command from keypad, remote or communications port
 2. Speed command from keypad, remote or communications port
 3. Motor direction selection
 4. Maximum and minimum speed limits
 5. Acceleration and deceleration times, two settable ranges
 6. Critical (skip) frequency avoidance
 7. Torque limit
 8. Multiple attempt restart function
 9. Multiple preset speeds adjustment
 10. Catch a spinning motor start or normal start selection
 11. Programmable analog output
 12. DC brake current magnitude and time
 13. PID process controller
 14. The VFD shall have the following system interfaces:
 - a. Inputs – A minimum of six (6) programmable digital inputs, two (2) analog inputs and serial communications interface shall be provided with the following:
 1. Remote manual/auto
 2. Remote start/stop
 3. Remote forward/reverse
 4. Remote preset speeds

5. Remote external trip
6. Remote fault reset
7. Process control speed reference interface, 4-20mA DC
8. Potentiometer and 1-10VDC speed reference interface
9. RS-232 programming and operation interface port
10. Serial communications port

B. Outputs – A minimum of two (2) discrete programmable digital outputs, one (1) programmable open collector output, and one (1) programmable analog output shall be provided, with the following.

1. Programmable relay outputs with one (1) set of Form C contacts for each, selectable with the following:
 - a. Fault
 - b. Run
 - c. Ready
 - d. Reversed
 - e. Jogging
 - f. At speed
 - g. Torque Limit Supervision
 - h. Motor rotation direction opposite of commanded
 - i. Over-temperature
2. Programmable open collector output with available 24VDC power supply and selectable with the following:
 - a. Fault
 - b. Run
 - c. Ready
 - d. Reversed
 - e. Jogging
 - f. At speed

- g. Torque Limit Supervision
 - h. Motor rotation direction opposite of commanded
 - i. Over-temperature
3. Programmable analog output signal, selectable with the following:
- a. Motor current
 - b. Output frequency
 - c. Frequency reference
 - d. Motor speed
 - e. Motor torque
 - f. Motor power
 - g. Motor voltage
 - h. DC-bus voltage
 - i. AI1 (Analog Input 1)
 - j. AI2 (Analog Input 2)
 - k. PT100 temperature
 - l. FB digital input 4 (Field Bus Input)
4. Monitoring and Displays
- a. The VFD display shall be a LCD type capable of displaying three (3) lines of text and the following thirteen (13) status indicators:
 - 1. Run
 - 2. Forward
 - 3. Reverse
 - 4. Stop
 - 5. Ready
 - 6. Alarm
 - 7. Fault
 - 8. Input/Output (I/O) terminal

9. Keypad
 10. Bus/Communication
 11. Local (LED)
 12. Remote (LED)
 13. Fault (LED)
5. The VFD keypad shall be capable of displaying the following monitoring functions:
- a. Output frequency
 - b. Frequency reference
 - c. Motor speed
 - d. Motor current
 - e. Motor torque
 - f. Motor power
 - g. Motor voltage
 - h. DC-bus voltage
 - i. Unit temperature
 - j. Calculated motor temperature
 - k. Voltage level of analog input
 - l. Current level of analog input
 - m. Digital inputs status
 - n. Digital and relay outputs status
 - o. Analog Input
6. Protective Functions
- a. The VFD shall include the following protective features:
 1. Over-current
 2. Over-voltage
 3. Inverter fault

4. Under-voltage
 5. Input phase loss
 6. Output phase loss
 7. Under-temperature
 8. Over-temperature
 9. Motor stalled
 10. Motor over-temperature
 11. Motor under-load
 12. Logic voltage failure
 13. Microprocessor failure
- b. The VFD shall provide ground fault protection during power-up, starting, and running. VFD with no ground fault protection during running is not acceptable.
7. Diagnostic Features
- a. Fault History
 1. Record and log faults
 2. Indicate the most recent first, and store up to 30 faults
8. Additional features to be included in the VFD:
- a. HMCP or thermal magnetic breaker to provide a disconnect means. Operating handle shall protrude through the door. The disconnect shall not be mounted on the door. The handle position shall indicate ON, OFF, and TRIPPED condition. The handle shall have provisions for padlocking in the OFF position with at least three (3) padlocks. Interlocks shall prevent unauthorized opening or closing of the VFD door with the disconnect handle in the ON position. Qualified maintenance personnel can defeat door handle interlock.
 - b. Laminated plastic or steel nameplate engraved with user's identifying name or number for oversize enclosures.
 - c. 120 VAC control to allow VFD to interface with remote dry contacts.
 - d. A 3% line reactor shall be installed at the VFD output to reduce dv/dt levels and the resultant peak voltage overshoots at the motor terminals.

9. Enclosure

- a. The VFD enclosure shall be NEMA 12. The VFD shall have complete front accessibility with easily removable assemblies.

10. Spare Parts

- a. The main logic board, keypad and power supply board shall be supplied as spares, one for each different part number supplied.

11. The VFD manufacturer shall maintain, as part of a national network, engineering service facilities within 100 miles of project to provide start-up service, emergency service calls, repair work, service contracts, maintenance and training of customer personnel.

12. All VFD's shall be individually mounted.

13. Power for cooling shall be provided internal to the AC Drive unit by use of a control power transformer.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify that the location is ready to receive work and the dimensions are as indicated.
- B. Do not install AC Drive equipment until the building environment can be maintained within the service conditions required by the manufacturer.

3.02 FACTORY TESTING

- A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.
 - 1. All printed circuit boards shall be functionally tested via automatic test equipment prior to unit installation.
 - 2. After all tests have been performed; each VFD shall undergo a burn-in test. The drive shall be burned in at 100% inductive or motor load without an unscheduled shutdown.
 - 3. After the burn-in cycle is complete, each VFD shall be put through a motor load test before inspection and shipping.
- B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.03 PROTECTION - Before and during the installation, the ac drive equipment shall be protected from site contaminants.

3.03 INSTALLATION

- A. Installation shall comply with manufacturer's instructions, drawings and recommendations.
- B. The AC Drive manufacturer shall provide a factory certified technical representative to supervise the contractor's installation, testing and start-up of the AC Drive(s) furnished under this specification for a maximum total of 2 days.

3.04 FIELD QUALITY CONTROL

- A. Provide the services of a qualified manufacturer's employed Field Service Engineer to assist the Contractor in installation and start-up of the equipment specified under this section. Field Service personnel shall be factory trained with periodic updates and have experience with the same model of VFD on the job site. Sales representatives will not be acceptable to perform this work. The manufacturer's service representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, installation as specified in manufacturer's installation instructions, wiring, application dependant adjustments, and verification of proper VFD operation.
- B. The Contractor under the technical direction of the manufacturer's service representative shall perform the following minimum work.
 - 1. Inspection and final adjustments.
 - 2. Operational and functional checks of VFD and spare parts.
 - 3. The contractor shall certify that he has read the drive manufacturer's installation instructions and has installed the VFD in accordance with those instructions.
- C. The Contractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made.

3.05 TRAINING

- A. An on-site training course of 2 training days shall be provided by a representative of the AC Drive manufacturer plant and/or maintenance personnel and quoted as a separate line item.

- B. The training program shall consist of the following:
1. Instructions on the proper operation of the equipment.
 2. Instructions on the proper maintenance of the equipment.

END OF SECTION

SECTION 16500

LIGHTING

PART 1 GENERAL

1.1 SCOPE

- A. Perform all work necessary and/or required and furnish all materials and equipment for construction of a complete system of indoor and outdoor building lighting.
- B. Consult Section 16050 for related work, materials and methods specified in that Section.

1.2 SUBMITTALS

- A. Furnish Shop Drawings and descriptive data, complete with project designation for lighting fixtures.
- B. Shop Drawings shall be in accordance with General Conditions and Supplementary Conditions of these Specifications.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 2 PRODUCTS

2.1 MANUFACTURERS

Products: Subject to compliance with requirements, provide products scheduled on Drawings.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

- C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- E. Metal Parts: Free of burrs and sharp corners and edges.
- F. Sheet Metal Components: Steel unless otherwise indicated. Form and supported to prevent warping and sagging.
- G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.
- H. Diffusers and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. Material having High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 2. Glass: Temperature glass unless otherwise indicated.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

- A. General Requirements for Electronic Ballasts:
 - 1. Comply with UL 935 and with ANSI C82.11.
 - 2. Designed for type and quantity of lamps served.
 - 3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
 - 4. Sound Rating: Class A.
 - 5. Total Harmonic Distortion Rating: Less than 20 percent.
 - 6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 - 7. Operating Frequency: 42 kHz or higher.
 - 8. Lamp Current Crest Factor: 1.7 or less.
 - 9. BF: 0.88 or higher.

10. Power Factor: 0.98 or higher.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

- A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
1. Lamp end-of-life detection and shutdown circuit.
 2. Automatic lamp starting after lamp replacement.
 3. Sound Rating: Class A.
 4. Total Harmonic Distortion Rating: Less than 20 percent.
 5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 6. Operating Frequency: 20 kHz or higher.
 7. Lamp Current Crest Factor: 1.7 or less.
 8. BF: 0.95 or higher unless otherwise indicated.
 9. Power Factor: 0.98 or higher.
 10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

2.5 BALLASTS FOR HID LAMPS

- A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features unless otherwise indicated:
1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
 2. Minimum Starting Temperature: Minus 22 deg F for single-lamp ballasts.
 3. Rated Ambient Operating Temperature: 104 deg F.
 4. Open-circuit operation that will not reduce average life.
- B. Electronic Ballast for Metal-Halide Lamps: Include the following features unless

otherwise indicated:

1. Minimum Starting Temperature: Minus 20 deg F for single-lamp ballasts.
2. Rated Ambient Operating Temperature: 130 deg F.
3. Lamp end-of-life detection and shutdown circuit.
4. Sound Rating: Class A.
5. Total Harmonic Distortion Rating: Less than 20 percent.
6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
7. Lamp Current Crest Factor: 1.5 or less.
8. Power Factor: 0.90 or higher.
9. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.

2.6 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

- e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.7 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
 - 1. Battery: Sealed, maintenance-free, lead-acid type.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 6. Integral Time-Delay Relay: Holds unit on for fixed interval of 10 minutes when power is restored after an outage.

2.8 FLUORESCENT LAMPS

- A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches, 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3500 K, and average rated life of 30,000 hours (3hr/start) unless otherwise indicated.
- B. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at three hours operation per start unless otherwise indicated.
- C. Metal-Halide Lamps: ANSI C78.43, with minimum CRI 65, and color temperature 4000 K.
- D. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.

2.10 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Section 16050 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- E. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- F. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- G. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- H. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
 - 1. Reflecting surface of metal bowls and shades finished synthetic white, baked at 250 °F or higher, except as otherwise noted.
 - 2. Use of the word "acrylic" in lighting fixture description means 100% virgin acrylic plastic.
- I. All fixtures shall bear UL Label.

2.9 LAMPS

- A. The Contractor shall provide lamps for all fixtures.
 - 1. Incandescent lamps: Inside frosted, 130 volt, screw type; extended service where available.
 - 2. Fluorescent lamps: Standard cool white, except as indicated otherwise.
 - 3. High Pressure Sodium-Superior Performer clear bulb type where available.
- B. All fixtures shall have lamps in proper working order at time of final acceptance of building by Owner.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture. Lighting layouts indicated are generally diagrammatic and location of outlets and equipment is approximate; exact location of fixtures shall be governed by physical conditions and be adjustable where applicable.

- B. Comply with NFPA 70 for minimum fixture supports.
- C. Provide all support hardware for installation of lighting fixtures as follows:
 - 1. Provide suitable support independent of outlet boxes as required.
 - 2. Supports for fixtures other than by outlet box shall be preset concrete inserts, or expansion anchors as required.
 - 3. Fixtures weighing more than 50 pounds shall be supported independently of the outlet box.
 - 4. Fasten exterior fixtures with non-corrosive hardware.
- D. Polarize each fixture.
- E. Fixtures shall be wired in strict accordance with latest requirements of NFPA 70.
 - 1. Protect wiring with tape or tubing at all points where abrasion is liable to occur.
 - 2. Conceal all wiring within fixture construction.
 - 3. Do not locate splice or tap within arm or stem.
 - 4. Install wire continuous from splice in outlet box on building wiring system to lampholder or to ballast and from ballast to lampholder.
 - 5. Splices shall be made with specified screw-on connectors to wiring within fixture or in connecting fixture wire to wiring of building.

3.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION

SECTION 16900

ELECTRICAL CONTROLS AND INSTRUMENTATION

PART 1 GENERAL

1.01 SCOPE

- A. Perform all work necessary and/or required and furnish all materials and equipment for complete system of electrical controls for the project. Such work includes, but is not limited to, the following:
1. Installation of electrical controls and instrumentation devices in association with the installation of the water treatment plant improvements.
 2. Installation of miscellaneous relays, contractors, level, flow & pressure monitoring, lighting/surge protectors, intrinsically safe barriers, operators, pilot lights, signal devices, control devices and control and interface panels.

- 1.02 RELATED WORK SPECIFIED ELSEWHERE - Refer to the following specification sections for additional information. The information included in these sections does not supersede any information included herein, but complements and supplements it.

Section 16483 - Variable Frequency Drives (1- 60 HP)

Section 16484 - Variable Frequency Drives (75 HP and Larger)

Section 16920 - Water Sewage Control Expansion

1.03 SUBMITTALS

- A. Furnish submittals and descriptive data, complete with project designation, as described in Section 16010.
- B. Submittals shall fully demonstrate that the equipment and services to be furnished will comply with the provisions of this Section and shall provide a true and complete record of the equipment as manufactured and delivered. Submittals shall be bound in separate three-ring binders, with an index and sectional dividers, with all Drawings reduced to a maximum size of 11-in by 17-in for inclusion within the binder.

Separate submittals shall be made as follows:

1. Project plan – which shall include a list of submittals and intended date of release for review. This plan must be accepted before any shop drawing submittals will be processed.
2. Instrumentation and controls
3. The project plan shall be submitted and approved before any further submittals will be accepted.

C. Instrumentation and Controls

1. This submittal shall provide complete documentation of all field instruments, control panels and other instrument and control equipment.
2. Provide equipment specification sheets, which shall fully describe the devices, the intended function, how it operates and its physical environmental and performance characteristics. Each data sheet shall have appropriate cross-references to control devices or equipment identification tags.
3. Provide detailed diagrams on a single 11-in by 17-in or 8.5-in by 11-in sheet showing the following requirements:
 - a. Show all interconnecting wiring between equipment, panels, terminal junction boxes and field mounted components. The diagrams shall show all components and panel terminal board identification numbers and all wire numbers. This diagram shall include all intermediate terminations between field elements and panels (e.g. terminal junction boxes). The diagrams shall be coordinated with the electrical supplier and shall bear his/her mark showing this has been done.
 - b. Show location of all devices.
 - c. Show instrument description showing type, manufacturer, model number, range, set points and operation (e.g. fail open, open on tenderization, normally closed, etc.) as applicable.
 - d. Show all instrument loop power back to termination on terminal block, fuse block (including fuse size), etc, as applicable.
 - e. Show all grounding points within cabinets and panels and identify the connection point of individual components.
5. Provide detailed Drawings covering control panels consoles and/or enclosures, which shall include:
 - a. Cabinet assembly and layout Drawings to scale. These shall include both front and interior layouts.
 - b. Material, fabrication and painting specifications.
 - c. Panel wiring diagrams showing all power connections to equipment within and on the panel, combined panel power draw requirements (volts, amps), breaker sizes, fuse sizes and grounding. This wiring diagram shall be in ladder logic format and shall reference the appropriate drawing for continuations or details where required. Show all wire numbers, and terminal block designations.

6. All equipment and control panel submittals must be approved prior to acquisition of materials and construction of control panels.
7. The submittal shall also contain all planning information, site preparation instructions, grounding and bonding procedures, cabling diagrams, plug identifications, safety precautions or guards and equipment layouts in order to enable the Contractor to proceed with the detailed site preparation for all equipment.

1.04 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM).
 1. ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- B. Instrument Society of America (ISA)
 1. ISA S5.2 - Binary Logic Diagrams for Process Operations
 2. ISA S5.3 - Graphic Symbols for Distributed Control/Shared Display Instrumentation Logic and Computer Systems.
 3. ISA S5.4 - Standard Instrument Loop Diagrams
- C. American National Standards Institute (ANSI)
 1. ANSI X3.5 - Flowchart Symbols and Their Usage in Information Processing
- D. National Electrical Manufacturers Association (NEMA)
- E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 CONTRACTOR RESPONSIBILITY

- A. It shall be the Contractor's responsibility to furnish a complete and functional, fully integrated package of controls and instrumentation as described in this bid package. This includes all hardware devices necessary to interface the components of the various systems.
- B. Responsibility shall include review of all appropriate drawings and specifications sections for this entire project. This shall include review of specifications for all equipment, electrical contract drawings and specifications, and any other equipment interfacing to the control panel systems, as required to provide necessary point-to-point wiring schematics and compliance with the functional requirements of these specifications.
- C. All special cables, such as co-axial cable, or sensor/transmitter specialty interconnection wiring, shall be furnished.

- D. The contractor shall be responsible for the detailed design, installation and the proper functioning and performance of the control and instrumentation systems, the operator interface, the preparation of the required submittal data, conducting all tests, calibrations and operational demonstrations, and providing technical supervision for the installation and connections to equipment. The system supplier shall not necessarily be the manufacturer of the equipment to be furnished.
- E. The contractor shall, for the duration of this contract and the guarantee period, provide next day, on-site service for all controls and instrumentation problems as discussed in other areas of this specification.
- F. Provide integrated operation and maintenance manuals and operation training.

1.06 QUALITY ASSURANCE

- A. The manufacturers of the equipment and fabricators of panels and/or cabinets supplied under this Section shall allow the Engineer and/or Owner to inspect and witness the testing of the equipment at the site of fabrication. Equipment shall include the cabinets, special control systems, level measuring devices and other pertinent systems and/or devices. A minimum of ten (10) working days notification shall be provided to the Engineer prior to testing. No shipments shall be made without the Engineer's prior, written approval.

1.07 WARRANTY

- A. The warranty shall provide (a) a minimum of next-day, on-site service for emergency failures, and (b) replacement of the defective component within one week, if repairs cannot be affected within that time. A five-day response time, on-site service, is required for non-critical failures. Warranty work shall be provided by the installation Contractor. This warranty shall cover a period of one year from the date of final acceptance of the project.

PART 2 PRODUCTS

2.01 MISCELLANEOUS COMPONENTS

- A. Pilot Type Indicating Lights
 1. Type: Heavy-duty, push-to-test, oiltight, which utilize a LED 7-lumen lamp.
 2. Functional/Performance:
 - a. Units shall be provided with lamps having a voltage rating suitable for the voltage supplied.
 - b. Lamps shall be replaceable from the front of the unit.
 3. Physical:
 - a. Lens color shall be as indicated on the drawing. Lens shall be approximately 1-1/4-in in diameter.

b. Units shall be UL rated NEMA-13 for indoor panels. Units located outdoors or indicated to be weatherproof shall be rated NEMA-4X.

4. Manufacturers: Square-D, Type-9001, or equal of Allen-Bradley, or Eaton

B. Selector Switches and Pushbutton Operators

1. Type: Operators shall be 30 mm heavy-duty, oiltight, with stackable contact blocks.

2. Functional/Performance: Provide contact arrangement and switching action as required for the control system specified.

3. Physical:

a. For 120 VAC services provide contacts rated 10 Amps at 120 VAC.

For 24 VDC services provide silver sliding contacts rated 5 Amps at 125 VDC.

For electronic (millivolt/ milliamp) switching provide contacts rated lamp at 28 VDC.

b. Pushbuttons shall have flush operators.

Selector switches shall have knob or wing-lever operators.

c. Indoor units shall be rated NEMA-13.

Units located outdoors, or indicated needing to be weatherproof, shall be rated NEMA-4X.

d. Provide legend plates denoting switch/pushbutton position/ function.

e. Provide padlock attachments for outdoor selector switches and pushbuttons, and where indicated otherwise. Padlock attachments for lock-out-stop pushbuttons shall hold button in the depressed position.

4. Options/Accessories Required:

a. Provide lock-out-pushbuttons, key-operators, etc, as indicated on the drawing.

b. Provide make-before-break bridging contacts where required.

c. Provide operators in Type 304 stainless steel enclosures.

5. Manufacturers: Square-D, Class-9001, Type-K, or equal of Allen-Bradley, or Eaton.

- B. Speed Potentiometer
1. Type: Operator shall be 30 mm heavy-duty, oiltight, water tight, and dust tight
 2. Single operator with dial plate and black knob in NEMA 4/13 enclosure.
 3. UL Listed E42259 CCN NKCR
 4. 2.5KOHMS (or as required for controller speed input
 5. Manufacturers: Square-D Class-9001, Type SK, or equal of Allen-Bradley or Eaton.
- C. General Purpose Relays
1. Type: Relays shall be of the plug-in type having tubular terminals.
 2. Functional/Performance:
 - a. Coil voltage shall match supply voltage.
 - b. Duty cycle shall be rated for continuous operation.
 3. Physical:
 - a. Contacts rated 12-Amps at 120-Vac
 - b. Relays to have 3PDT contact arrangement.
 - c. Coil power requirement: 3.0 VA
 4. Options/Accessories Required:
 - a. Provide mounting sockets rated for the supply voltage and current.
 - b. Provide DIN mounting tracks as required.
 - c. Provide relay hold-down clip.
 5. Manufacturers: Square-D, Class 8501, Type KP13, or equal of Allen-Bradley, Cutler-Hammer, or Potter & Brumfield.
- E. Interposing Relays
1. Type: Relays shall be of the plug-in PLC type for mounting on a DIN rail.
 2. Functional/Performance:
 - a. Coil voltage: 12 VDC
 - b. Duty cycle shall be rated for continuous operation.

3. Physical:
 - a. Contacts rated 6A continuous at 120-Vac, with 1500VA interrupting rating
 - b. Relays to have 2PDT contact arrangement
 - c. Coil power requirement: 0.4W (max) at 12 VDC
4. Options/Accessories Required:
 - a. Provide base terminal block having screw connections
 - b. Provide DIN mounting tracks as required
 - c. Provide relay hold-down clip
 - d. UL-Listed
5. Manufacturers: Phoenix Contact, Part Number 2967235, or equal of Finder, Weidmuller, or Schneider Electric/Telemecanique.

F. Terminal Blocks

1. Type: NEMA Type high-density solderless box lug
2. Functional/Performance: Rated: 600V, 30A
3. Physical:
 - a. Mounts on standard DIN track
 - b. Block Material: Nylon
 - c. Wire Type: Solid or stranded copper
 - d. Wire Range: #22 to #10 AWG
4. Options/Accessories Required:
 - a. Provide DIN mounting track as required.
 - b. Provide end barriers as required.
 - c. UL Listed
5. Manufacturers: Square-D, Class 9080, Type GM6, or equal.

G. Ambient Temperature Switches

1. Temperature switches for ambient indoor temperatures.
2. Provide wall-mount temperature switch (thermostat) with the following requirements:

- a. Allowed temperature: 40°F to 110°F
 - b. Standard material: anodized aluminum
 - c. Contacts: 25A, 120VAC, SPDT
 - d. Differential: 2.5°F
 - e. Enclosure: NEMA 4X, Cast construction with epoxy gray finish
3. Manufacturers – Marley/Qmark Model WT11A or equal.

H. Smoke Detectors

- 1. Smoke detectors shall be of the dual chamber, solid-state ionization, single and/or multiple station type with preset sensitivity. Mounting plate shall securely attach to a junction box, with detector twisting onto the mounting plate. Dual 120 VAC and 9 VDC power, with green and red power indicators. Firex, Model No. i4618A, or approved equal.
- 2. A relay module, with Form-C contacts rated 5 amps, 120 VAC; 120 volt powered by smoke detector interconnect controlled circuit. Firex, Model No. SM120X, or approved equal.
- 3. Standards: U.L. 217, and comply with FHA and NFPA requirements.
- 4. Manufacturer: Kidde or equal.

2.02 FLOAT TYPE LEVEL SWITCH

A. Type:

- 1. The switch assembly shall be weighted and suspended on its own cable.

B. Functional/Performance:

- 1. Temperature Rating - 0 to 50 degrees C
- 2. Contact Rating - Up to 250 VAC/VDC, and 10 Amps AC, 5 Amps DC.
- 3. Contact Arrangement - Normally Open or Open as required

C. Physical:

- 1. Contact - Sealed mercury switch housed in a chemical-resistant polypropylene casing.

2. Flexible Support Cable - Synthetic three wire cable, minimum 19 AWG wire.
3. Specific Gravity - Match to fluid being measured.

D. Options/Accessories Required:

1. Provide flexible support cable of sufficient length to ensure that splices are made in junction boxes.
2. Provide junction box outside the tank for connection of cable.
3. Provide stainless steel supports/mounting accessories as required.
4. Provide weight located on support cable to provide level function indicated.

E. Manufacturer: Warrick – Series M or equal

2.03 FLOW SWITCH

A. Type: Thermal dispersion switch with relay controller

B. Switch Long Sensor:

1. Range: 0.04 to 10 fps
2. Response Time: 1 – 10 seconds
3. Supply Voltage: 12 – 36 VDC
4. Current Consumption: 50 Ma
5. Probe Material: Polypropylene/Ryton
6. Mounting Thread: 3/4" NPT
7. Cable Type: 3-wire, 22 gauge with ground shield and PP jacket

C. Relay Controller

1. Supply Voltage: 120VAC, 60 Hz.
2. Sensor Supply: 13.5VDC @ 100 mA
3. Relay Load: 250VAC, 16A, ½ hp
4. Relay Mode: Selectable, NO or NC (Field set for NO)
5. Time Delay: 0 to 60 seconds (Field set to existing time delay)

6. Enclosure Rating: NEMA 4X/IP65
 7. Enclosure Material: Polypropylene (U.L. 94 VO)
 8. Temperature Range: F: -40° to 158°
 9. Conduit Connection: ½” NPT
- D. Manufacturer: Flowline FT10 Series Flow Switch Sensor with LC30 Series Relay Controller or equal.

2.04 SUBMERSIBLE LEVEL TRANSDUCER

- A. Sensor
1. Type:
 - a. Submersible, pressure transmitter with internal surge protector.
 - b. Silicon pressure cell with integral, compliant barrier diaphragm, and transmitter having 4 to 20 mA output.
 2. Performance:
 - a. Range: 0-10 ft. H₂O nominal (adjust range to suit each application).
 - b. Accuracy: ±0.50% FSO BFSL.
 - c. Thermal Error: ±0.05% FSO/°C ref at 25°C.
 - d. Proof Pres.: 1.5 X rated pressure.
 - e. Burst Pres.: 2.0 X rated pressure.
 - f. Resolution: Infinitesimal.
 3. Environmental:
 - a. Comp. Temp. Range: 0° to 50°C.
 - b. Operating temp. Range: -20° to 60°C.
 4. Electrical:
 - a. Excitation/Signal: 2-wire, 4-20 mA loop-powered
 - b. Output Current: 4-20 mA
 - c. Zero offset, max: ±0.12 mA.
 - d. Output impedance: 10 ohms.
 - e. Electrical Classification: Class-I, Division-1, Groups-C-D

5. Physical:
 - a. Weight: 3.5 lbs. (not incl. cable).
 - b. Cable: Shielded, 4-conductor, polyurethane jacket, and molded polyurethane cable seal. Length as required.
 - c. Vent tube: polyethylene with Aneroid Bellows.
 - d. Wetted Materials: 316 SST. Viton suspended by cable.
- B. Manufacturer: KPSI, Model 710, with Series 815 Aneroid Bellows, and 009 surge protection or approved equal.

2.05 ULTRASONIC LEVEL DETECTION SYSTEM

- A. Provide an ultrasonic level detection system for sensing the level in the Caustic storage tanks. A 6" flanged nozzle shall be provided for mounting the sensor.
- B. The sensing probe shall have a measuring range of 0.3 to 10 meters (1 to 33 ft) and be constructed of PVDF (Kynar). Sensor shall be internally temperature compensated, and have an IP68 degree of protection. Sensor shall be supplied with to 30 meters of RG 62 A/U coaxial cable. Mounting shall be 2" NPT into a tapped blind flange; flange adapter shall be provided. Sensor shall be a Siemens Echomax ST-H, Catalog No. 7ML1100-3C20 or equal.
- C. Indicating Transmitter shall be an outdoor / indoor mountable unit (IP65 / NEMA 4X) for 120VAC power supply. Display shall be a 100 X 44 mm multi-block backlit LCD. Software and parameters shall be stored in non-volatile memory. Unit shall be capable of accepting input from ultrasonic sensing probes. Accuracy shall be 0.25% of range, or 6mm, whichever is greater. Unit shall have one isolated 4-20maDC outputs and three (3) SPDT alarm relay outputs. Transmitter shall be a Siemens MultiRanger 100, Catalog No. 7ML5033-1AA001A or equal.
- D. Provide hand programmer for Siemens MultiRanger, Siemens cat no. 7ML1830-2AK or equal.

2.06 PRESSURE INDICATING LEVEL TRANSMITTER

- A. Design pressure indicator transmitter to sense and transmit water pressure.
- B. Provide pressure transmitter with the following requirements:
 1. Transducer to be an integrated circuit sensor type with true gauge pressure reading.
 2. Primary fill-fluid:

3. Diaphragm material: 316 stainless steel.
 4. Process Connection: 316L SST ½-14 NPT Female.
 5. Electrical Connection: Screwed gland ½-14 NPT
 6. Transient Protection per IEEE C62.41.2-2002, Location Category B
 7. Integral indicator: LCD Display with Local Operator Interface
 8. Damping: Adjustable up to 15 seconds minimum.
 9. Adjustment: Integral zero and span adjustments.
 10. Power Supply: Loop power 24 VDC.
 11. Transmitter Output: 4-20 mA dc / Digital HART Protocol.
 12. Calibration certificate
 13. Enclosure: NEMA 4X, Die Cast Aluminum with polyurethane finish
 14. NSF Drink Water Approval
 15. Temperature Limits: -40 to 185°F
 16. Transmitter Ranges: -14.7 to 150 psi
- C. Transmitter Ranges: Provided for the pressure range and spans to suit operating conditions.
- D. Manufacturer: Rosemount 2088 or equal.

2.07 24 VDC POWER SUPPLIES

- A. General
1. Mounting: DIN-Rail
 2. Power range of 15 - 480 W
 3. Standard functions: Power Factor Correction, overload and overvoltage protection
 4. International safety standards: UL, cUL, UL508 Listed, SEMI F47 and CE
 5. Class 2 output (90 W models and below)
 6. Universal input 100 to 240 VAC (85 to 264 VAC), single-phase with LED output indicator
 7. Maintenance forecast (lifetime) monitor provides replacement indication to ensure machine uptime.

8. Total run-time monitor displays operating duration of load
9. 90 W and above models have 2 alarm outputs; 1 for Undervoltage output and 1 for Lifetime or Run-time monitor
10. 3-year warranty

C. Manufacturer / Model – Omron S8VS Series or equal

2.08 DC TO DC ISOLATED SIGNAL SPLITTER TRANSMITTER

A. Electronic module providing isolation, output slitting, output device separation, and redundancy or a combination of these. Module shall accept a single 4-20 mA current input and provide two optically isolated 4-20 mA outputs.

B. Data:

1. Input Range: 4-20 mADC
2. Input Impedance: 50Ω typical
3. Voltage Burden: 1.25 VDC Max. at 20 mA current input
4. Input Loop Power Supply: 15 VDC \pm 10%, regulated, 25 mADC
5. LED Indicators: Variable brightness LEDs indicated I/O loop level and status one for input, one for each output
6. Output Range: Channel 1: 4-20 mADC, Channel 2: 4-20 mADC
7. Output Linearity: Better than 60.1 % of span
8. Output Zero and Span: Multi-turn zero and span potentiometers for each output channel to compensate for load and lead variations \pm 15% of span adjustment range typical
9. Output Loop Power Supplies: One for each output channel, 20 VDC nominal, regulated, 25 mADC (May be selectively wired for sinking or sourcing mA output.
10. Output Ripple and Noise: Less than 10mV_{RMS}
11. Output Functional Test: Front buttons set each output to test level when pressed. Each test level potentiometer adjustable 0-100% span
12. Response Time: 70 milliseconds typical
13. Common Mode Rejection: 120 dB minimum
14. Isolation: Full 4-way isolation; input 1, output 1, output 2, power 1200 V_{RMS} minimum

- 15. Power:
 - a. Model-I; 85-265 VAC, 50/50 Hz or 60-300 VDC, 6 W maximum
 - b. Model-I-DC; 9-30 VDC or 10-32 VAC

16. Housing: IP 40, mounts to standard 35 mm DIN rail

C. Manufacturer: OMEGA DRSP Series or equal.

2.09 CONTROL PANELS, COUNSELS, AND CABINETS

The following paragraphs describe general fabrication requirements of control panels, consoles, and cabinets.

A. Wiring

1. All interconnecting wiring, except for electronic circuits, shall have 600 Volt insulation, and be rated for not less than 90-degrees C.
2. Power distribution wiring on the line side of fuses shall be 12 AWG minimum. Control wiring on the secondary side of fuses shall be 14 AWG minimum. Electronic analog circuits shall utilize 16 AWG, shielded, twisted-pair cable, insulated for not less than 300 Volts.
3. Power and low-voltage dc wiring systems shall be routed in separate wireways. Crossing of different system wires shall be at right angles. Different system wires routed parallel to each other shall be separated by at least 12-in. Different wiring systems shall terminate on separate terminal blocks. Wiring troughs shall not be filled to more than 60 percent visible fill.
4. All wiring shall terminate on terminals, and be numbered. Terminal blocks shall be barrier type with the appropriate voltage rating (600 Volts minimum). They shall be the raised-channel mounted type. Wire connectors shall be the hook-fork type, with non-insulated barrel for crimp-type compression connection to the wire. Wire and tube markers shall be the sleeve-type with heat-impressed letters and numbers. Direct interlock wiring between equipment will not be allowed. Only one side of a terminal block row shall be used for internal wiring. The field wiring side of the terminal shall not be within 3-in of the panel side.
5. All wiring to hand switches and the like, which are live circuits independent of the panel's normal circuit breaker protection, shall be clearly identified as such.
6. All wiring shall be clearly tagged and color-coded. All tag numbers and color-coding shall correspond to the panel wiring diagrams. All power wiring, control wiring, grounding, and DC wiring shall utilize different color insulation for each wiring system used.
7. All protecting devices shall be clearly labeled and located for ease of maintenance.
8. Provide surge protectors on all incoming power supply lines at each panel.

9. Panels are to be furnished with all control devices completely wired. Terminals shall be provided for all incoming and outgoing field wiring. Wiring and terminal blocks shall be marked with identification matching numbering shown on design drawings.
10. Segregation of signal types/voltage levels shall be maintained.

B. Control Components

1. All components required for the monitoring and control functions specified and or required shall be provided.

C. Equipment Mounting/Arrangement

1. All components shall be mounted in a manner that shall permit servicing, adjustment, testing, and removal without requiring disconnecting, moving, or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates, not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Mounted components shall be oriented in accordance with the internal components, and shall be identified with suitable plastic or metal engraved tags. Attached tags with drive pins adjacent to (not on) each component, identifying the component in accordance with the drawing, specifications and supplier's data.
2. All exterior panel-mounted equipment shall be installed with suitable gaskets, faceplates, etc., required to maintain the NEMA rating of the panel.

D. Nameplates and Labels

1. All panels shall be supplied with suitable nameplates, which identify the panel and individual devices as required.
2. Engraved laminated plastic nameplates shall be furnished and mounted for each front-panel-mounted and interior-mounted component. All instruments and components shall be tagged with embossed plastic tape labels.

E. Indoor Wall Mounted Cabinets

1. Unless noted otherwise on the Contract Drawings, all indoor panels shall be a minimum of a NEMA-12 and fabricated of not less than USS 14-gauge steel.
2. All panels shall be Hoffman, or equal.

F. Provide transient suppression devices as needed in each panel.

- G. Shop drawings shall be submitted as a single-submission package consisting of the following:
1. Enclosures and all associated component hardware.
 2. Complete wiring diagrams, showing devices, wiring, and terminal blocks numbered and labeled.
 3. Front panel arrangement drawings
 4. Interior arrangement drawings.
- H. **SERIALIZED UL LABEL REQUIREMENT (508A)** – all control panels provided under this section through section 16940 inclusive, shall be constructed in compliance with Underwriter's Laboratories Inc. category 508A standards - Enclosed Industrial Control Panels listing and following-up. The control panel(s) shall bear the Underwriter's Laboratories serialized label for "Enclosed Industrial Control Panel".
1. While the use of U.L. listed components is encouraged, their use alone will not be considered an acceptable or satisfactory alternate to the "Enclosed Industrial Control Panel" serialized label specified above.
 2. Upon request from the Engineer, the panel manufacturer shall supply documentation to the owner proving they are a U.L. recognized manufacturing facility for the type of equipment required.
 3. Only the labeled products of U.L.508A/"Enclosed Industrial Control Panel" recognized panel manufacturer would be considered acceptable for use on this project.

2.10 INSTRUMENT IDENTIFICATION

- A. Nameplates shall be provided as required. Nameplates shall be black laminated plastic with white center, fastened with stainless steel screws.
- B. The size and shape of nameplates and lettering shall be in pleasing proportion for each specified location.

2.11 LIGHTNING/SURGE PROTECTION

- A. Lightning/Surge protection shall be provided to protect the electronic instruments from induced surges propagating along the signal and power supply lines. The protection systems shall be such that the protective level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level and be maintenance free and self-restoring. Protectors on intrinsically safe circuits shall be suitable for such use. Ground wires for all surge protectors shall be connected to a good earth ground and where practical each ground wire run

individually and insulated from each other. These protectors shall be mounted within the instrument enclosure, control cabinet or a separate NEMA 4 junction box coupled to the enclosure. The units shall be Phoenix Contact MCR Plugrab Series protectors or equal.

- B. Power Supply - Protection of all 120 VAC instrument power supply lines shall be provided. Cabinet(s)/panel(s) and groups of field instruments regardless of location (indoor or outdoor), shall be protected by isolation transformers and surge suppressors. An individual gas tube surge suppressors shall protect each field instrument.
- C. Signal Line - All signal lines when they enter or leave a building shall be protected through the use of gas tube surge arrestors, and Zener diode protectors. These shall be provided at both ends of the signal lines and as close to the instruments as possible.

PART 3 EXECUTION

3.01 EQUIPMENT INSTALLATION

- A. All items shall be installed in accordance with the manufacturer's recommendations.
- B. The Contractor shall furnish and install all material and hardware required to supply a complete and functional installation.
- C. Prior to connecting any signals, it shall be tested to verify that the signal is within the expected range and suitable for connection to the new control equipment.

3.02 EQUIPMENT CONTROL WIRING

- A. Provide all wiring, conduit, and final interlock and control connections required for successful start-up and turnover of a trouble-free system to the Owner.

3.03 FLOAT SWITCHES

- A. Install float switches at heights for level detection indicated.
- B. Provide all necessary hardware for proper support of float switches. Coordinate the installation to eliminate conflicts.
- C. All materials used shall be corrosion resistant.

3.04 LEVEL TRANSDUCERS

- A. Installation shall be performed in accordance with the manufacturer's recommended procedures.

- B. Calibrate transmitter with scaled 4-20mA DC output.
- C. Configure one set of programmable output contacts for the permissive operation range of Pump 1, 2 & 3 operations.

3.05 INSTRUMENTATION INSTALLATION

- A. Install instruments where indicated in accordance with manufacturers recommendations and contract performances.

END OF SECTION

SECTION 16920

WATER SYSTEM CONTROL EXPANSION

PART 1 GENERAL

1.1 WORK INCLUDED

- A. This section covers work necessary for the design, documentation, assembly, test, installation, field testing, startup, training, and final documentation for expansion of the of existing Plant Control Sysem with a new Water Plant Control Panel for control of the new treatment process.
- B. The naming of a manufacturer in this specification is not intended to eliminate competition or prohibit qualified manufacturers from offering equipment. Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired. The base bid shall be the specified Primex Controls system. Alternate equipment shall be submitted to the consulting Engineer at least 14 days prior to bid (in accordance with the following prebid submittal requirements). The Engineer will issue an addendum prior to bid listing approved alternate control systems.

1.2 GENERAL

- A. Major components of this system shall include the specified software, materials, equipment, and installation required to implement a complete and operational water system that will perform the specified sequence of operation and interface to the City's existing SCADA system. The new control system is to be equipped with all required hardware and software provisions to enable this system to be the City's Future Master controller for the SCADA system. Note: The programming required to move the existing SCADA master functionality into the new Water System Control Panel's (WSCP) PLC is not part of this contract.
- B. In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service, to the greatest extent possible, like items of equipment provided hereunder shall be the end products of one (1) manufacturer.
- C. Requirements for the electrical work associated with the installation of Control Panel WSCP and SCADA upgrades and associated instrumentation equipment are as specified in Division 16000 ELECTRICAL.

1.3 RESPONSIBILITY FOR COMPLETE SYSTEM

- A. The Contractor shall be responsible for and shall provide for the design, supply, delivery, installation, certification, calibration and adjustment, software configuration, testing and startup, Owner training, warranty and routine future

field services, of a complete coordinated system which shall perform the specified functions.

- B. The Owner and the Engineer will review system technical information as submitted by the Contractor for software; operating system, database, control strategies and the graphical user interface, i.e. report and log formats, graphics, trends, alarming, etc. for complete compliance with these specifications.

1.4 PREBID SUBMITTAL

A. General:

1. Any system supplier other than the named pre-approved system supplier must submit a pre-bid submittal document fourteen (14) calendar days prior to project bid date. Provide two bound copies, with tabbed dividers and contents organized and presented as hereinafter specified.
2. Pre-Bid approval does not exempt the Contractor from meeting all the requirements of the Contract Documents nor does it give any prior acceptance of any equipment, software or services. The Contract Documents are the final authority for acceptance of the work provided. The Pre-Bid Submittal is not a part of the contract documents and as such does not exempt the Contractor from the requirements of contract submittals described hereinafter.
3. Information contained in the Pre-Bid Submittal shall be considered public information. All data submitted will become and remain the property of the Owner; none will be returned.
4. It is intended that the Owner shall receive the full benefit of any savings in cost involved in materials substitution as a result of a reduction of the contract price should they decide to accept an alternate.
5. The Engineer's decision as to pre-bid approval shall be final. The Consulting Engineer shall be considered the sole judge of the merits of the alternate system and shall indicate pre-approval of the alternate system via a written addendum to the specifications prior to the actual bid date.
6. The right is reserved to reject any and all proposals, to waive any informality, irregularity, mistake, error or omission in any proposals received and to accept the proposal, as determined by the Engineer or Owner, deemed most favorable to the Owner's interests.

B. Contents:

1. Include a complete Table of Conformance to each and every paragraph or part of the specifications. Use a chart format with specification part identified, indicate whether each part is in compliance, a deviation or an exception to the

specific part. If an exception or deviation, include a narrative description as to how the deviation or exception can benefit the end-user of the system over that item specified.

2. Provide a block diagram of the proposed system showing all major components and their interconnections and interrelationships. Label each diagram and indicate all external power and communications interfaces. All diagrams shall be in an 11 by 17 format.
3. Provide a written overview of the proposed Control system and coordination to the existing SCADA system describing the principal functions and capabilities of the system's Existing PC, Existing and New PLC's, system, Existing and New communications and general system capabilities (maximum number of network nodes, PLC's and I/O points, communication protocols available, etc.).
4. Provide an equipment list with descriptive literature and specifications for the proposed system. Included on the list shall be all major hardware items. List shall include as a minimum, the manufacturer, the quantity provided, and model numbers for each.
5. Provide an operating system and software applications list with descriptive literature for the proposed system. Include all major software items, supplier name, quantity, and model numbers. Indicate whether any proposed software is proprietary and would not be turned over to the Owner.
6. The system supplier must be an authorized System Integrator for the named PLC hardware/software supplier. Verification certificates shall be submitted directly from the manufacturer of the PLC hardware. In addition, submit references for minimum of (5) locations where the PLC equipment has been successfully installed, including name, address and telephone number for the appropriate utility person to contact.
7. The system supplier must submit evidence that they employ in excess of 25 personnel, including no less than 15 technical staff to include Engineers, programmers, and Field Technicians. Submit the qualifications and license for a minimum of one professional Engineer in the direct employ of the system supplier. Identify with resumes all personnel who may be assigned the specified project.
8. The system supplier must submit evidence from a qualified surety indicating they can provide performance/payment and maintenance bonds for SCADA and telemetry general contracts with a project value to \$2,000,000. Additionally, the system supplier shall submit evidence that they carry a minimum of \$10,000,000 of umbrella liability insurance. Liability insurance shall include \$5,000,000 of "errors and omissions" insurance coverage. Bonding company must carry a rating of A or better. Insurance company must carry a rating of AAAA.

9. The system supplier must be an authorized facility for assembly of control panels in accordance with UL-508, 913, 698A standards as may be required by these specifications. Submit system supplier's UL number which verifies their panel assembly shop is capable of providing UL labeled control panels.
10. Provide a tentative construction schedule for completion of the project within the specified Contract period. Indicate the following activities with milestones: Mobilization, radio communications licensing, submittal preparation, submittal review, equipment procurement, equipment assembly, system configuration and programming, factory testing, system delivery, system installation, startup, field testing and training, and post acceptance routine service intervals.
11. Describe the system supplier's provisions for service, technical assistance and re-placement parts for the proposed system. Include the system supplier's 1-800-toll free number. Identify with resumes, all personnel who will be providing technical support services for the project after it is accepted.

1.5 SUBMITTALS

A. Hardware Submittals:

1. Before any components are fabricated, and/or integrated into assemblies or shipped to the job site, furnish submittal documents as specified in Sections 13400 and 16900 to the Engineer for their review. Submittals shall include full details, shop drawings, catalog cuts and such other descriptive matter and documentation as may be required to fully describe the equipment and to demonstrate its conformity to these specifications. Specifically, the Contractor shall submit the following materials:
2. Block diagram and operational description of the system showing all major components and their interconnections and interrelationships. Label each diagram and specify all external power and communications interfaces. All diagrams shall be in an 11 by 17 format. Required documentation sets shall be furnished in bound hardcopy and final documentation shall also be provided in electronic format on CD.
3. Drawings of equipment to be supplied shall include, as a minimum: overall dimension details for each panel, console, etc., including internal and external arrangements and door mounted operator devices with nameplate designations. Wiring diagrams of equipment including field device connections shall be included and specific installation/wiring requirements identified.
4. Operational Description shall include the principal functions/capabilities of the Operator Interface to the PLC and the PLC's as provided and configured /programmed. Included shall be a description of system communications.
5. Provide a detailed Bill of Materials along with descriptive literature identifying component name, manufacturer, model number, and quantity supplied.

B. Software Submittals:

1. Provide complete user manuals for all supplier configured software and firmware. For ancillary software such as operating systems, spreadsheets, etc. being supplied under this contract, only a listing of the manuals which will be included with the Operations and Maintenance documentation is required.
2. Sample communication and control database programs for project in hardcopy form. As a minimum, hardcopy form shall be fully documented, including code, comments, addressing data and cross-references, etc. Every line or section of code shall be accompanied by a comment describing its function.
3. Provide initial graphic display and report format layouts as described later in this specification. List and briefly describe all operator interface functions provided at the Water Plant Control Panel , including: alarm annunciation and acknowledgment, status displays, control capabilities, report generation, event logging, charting and trending, etc.

C. Test Outlines and Procedures Submittals

Test descriptions shall be in sufficient detail to fully describe the specific tests to be conducted to demonstrate conformance with this specification.

D. Spares and Expendable Recommendations

The Contractor shall provide a list of recommended spares and expendable items. The list shall be exclusive of any spares furnished under this Contract. A total purchase cost for the recommended list shall be provided in addition to the unit cost for each item.

1.6 ON SITE SUPERVISION

The Contractor shall provide experienced personnel to supervise, perform, and coordinate the installation, adjustment, testing, and startup of the Control system. The personnel shall be present on-site as required to effect a complete and operating system.

1.7 TESTING AND STARTUP

- A. All elements of the Control system shall be tested to demonstrate that the total system satisfies all of the requirements of this Specification. The Contractor shall provide all special testing materials and equipment. The Contractor shall coordinate and schedule all of his testing and startup work with the Owner. As a minimum, the testing shall include both a factory test and a field test. Testing requirements are as follows:

1. Factory Tests - The PLC's and all other associated hardware shall be tested at the factory, prior to shipment, so as to demonstrate that each component is operational and meets the requirements of these specifications. Test results shall be certified, with written documentation provided to the Owner upon test completion. The Owner or Engineer will not witness factory testing.
 2. Field Tests - All system components shall be checked to verify that they have been installed properly and that all terminations have been made correctly. Witnessed field tests shall be performed on the complete system. Each function shall be demonstrated to the satisfaction of the Owner and Engineer on a paragraph-by-paragraph basis.
- B. Each test shall be witnessed and signed off by the Contractor and the Engineer upon satisfactory completion. The Contractor shall notify the Owner at least one (1) week prior to the commencement date of the field tests.

1.8 TRAINING

- A. The training program shall educate operators, maintenance, engineering, and management personnel with the required levels of system familiarity to provide a common working knowledge concerning all significant aspects of the system being supplied. The training program shall consist of two 8-hour days. Both classroom-type and field site sessions shall be provided. At least two weeks prior to the requested start of the program, the proposed dates of training shall be submitted to the Owner and the Engineer for approval.
- B. The supplier shall provide all instructional course material, equipment and manuals to conduct the training program. Owner shall provide facilities for the training.

1.9 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall provide (6) complete sets of hard-covered ring bound loose-leaf O&M manuals. In addition to "as-built" system drawings, the manuals shall include internal wiring diagrams and operating and maintenance literature for all components provided under this section.
- B. The submitted literature shall be in sufficient detail to facilitate the operation, removal, installation, programming and configuration, adjustment, calibration, testing and maintenance of each component and/or instrument.
- C. Operation and Maintenance manuals shall include copies of all PLC programs written to accomplish the monitoring and control functions specified. Programs shall be updated after startup is complete, with the program(s) provided to the Owner on compact disk (CD). Two (2) copies to be provided.
- C. The contents of the O&M manuals shall be generally organized as follows:

1. System Hardware/Installation
2. System Software
3. Operation
4. Maintenance and Troubleshooting

1.10 DEFINITION OF ACCEPTANCE

A. System acceptance shall be defined as that point in time when the following requirements have been fulfilled:

1. All O&M documentation has been submitted, reviewed and approved.
2. The complete Water System Control, existing SCADA system and instrumentation have successfully completed all testing requirements specified herein and have successfully been started up.
3. All Owner's staff personnel training programs have been completed.
4. Owner/Engineer sign a document indicating Control system has formally been accepted.

1.11 ABBREVIATIONS AND DEFINITIONS

OIT	Operator Interface Terminal
PLC	Programmable Logic Controller
SCADA	Supervisory Control and Data Acquisition
UPS	Uninterruptible Power Supply
WSCP	Water System Control Panel (Master)
FSCP	Filtration System Control Panel (Remote Controller)
RCP	Residuals Control Panel (Remote Controller)

1.12 WARRANTY

The warranty shall provide (a) a minimum of next-day, on-site service for emergency failures, and (b) replacement of the defective component within one week, if repairs cannot be implemented within that time. A five-day response time, on-site service, is required for non-critical failures. The Systems Integrator responsible for the system installation shall provide service work under this warranty. This warranty shall cover a period of one year from the date of final acceptance of the project.

PART 2 PRODUCTS

2.1 GENERAL

- A. The functions and features specified herewith are the minimum acceptable requirements for the expansion of the plant's water system control consisting of Control Panel WSCP (Master) and remote Control Panels FSCP and RCP. The provided system shall equal or exceed each requirement.
- B. In some cases, the specifications may allow the accomplishing of certain functions by means of more than one hardware/firmware/software approach. Any approach that is proposed shall equal or exceed all functional, operational, convenience and maintenance aspects of the one described.
- C. Major equipment, component and software items are specified; however the Contractor shall, provide all appurtenant items necessary to achieve the required operation as hereinafter specified.
- D. The new Control Panel WSCP shall connect to the Existing Microcat Master 9710 controller as shown on the plan drawings and as described herein. The new Control Panel WSCP's PLC shall be a Siemens LC3000 controller with all components required to make the unit perform all of the functions required by this specification. The new LC3000 shall connect to the existing 9710 controller via hardwired serial connection to input Plant Process alarms and data. For future use, the new LC3000 shall be equipped with all components to enable this PLC to communicate to all existing remote RTU Units for future functionality as the SCADA System's Master.
- E. All control signals, status signals, alarm and process variable data shall be connected to the new LC3000. The system shall convert commands, alarms and variable analog data to digital blocks. The new LC3000 shall be capable of stand-alone control to maintain programmed logic. The new LC3000 will connect to the existing Microcat 9710 via an RS232 cable. The Microcat will poll the new LC3000 to input the required alarms and data to the existing Plant Control System.
- F. Units shall be furnished completely configured and tested providing the specified communication, monitoring, display, input/output, annunciation, computational and other requirements for operation of the Control system. Any additional components required for operation, whether specifically referenced herein or not, shall be provided.
- G. The PLC system shall be based on a scalable modular multi-use open architecture platform that can be efficiently applied to perform the necessary functions at the Plant as required in this specification.
- H. The PLC system shall support true system open architecture allowing use of specialized for water and wastewater hardware and software and full integration of

other third party generic hardware/software devices. The architecture shall meet the requirements as herein defined and allow economical expansion of function and features based on new and evolving technologies. Systems using non-scalable and/or closed proprietary architectures shall not be acceptable.

2.2 PLC SYSTEM

A. Hardware

1. The PLC system shall be based on a robust, field proven, current technology hardware platform allowing utilization of the latest advances in technology and permitting the most open programming and communication architectures. The PLC system shall be modular and scalable to be efficiently applied at each of the specified sites within the system.
2. The PLC system shall include a real time of day time clock w/battery back up for time stamping of data log records and scheduling of periodic time of day based events. Clock shall not require reset after a site power failure has occurred.
3. The PLC shall store system parameters including, logic configuration, setpoints, time delays, alarm and event data, counters and totalizers, etc.. in field programmable (FLASH) non-volatile memory. Sufficient non-volatile memory must be provided to protect at least 8,000 variables. The PLC shall also provide enough protected memory for time stamped data logging of up to 200,000 process values. This data shall be unaffected by power interruptions.
4. The PLC shall have enough processing power and working (DRAM) memory to enable high level programs such as Internet Web Servers to operate efficiently without affecting other simultaneous multitasking operations.
5. The PLC shall be furnished with a minimum of 6 communication ports with true multitasking and allow simultaneous support of all ports. Ports can be configured for local I/O, Operator Interface/display support, LAN/WAN, etc.
6. The PLC processor shall meet the following as a minimum:
 - a. CPU - True 32 Bit running at 50 MHz.
 - b. 16 MB – 32 bit Dynamic RAM
 - c. 8 MB FLASH
 - d. 512 KB Static RAM
 - e. 1 (One) Ethernet 10/100 BaseT port (RJ45)
 - f. 2 (Two) RS-232 Serial Communications (115 KB PS) (RJ45)
 - g. 1 (One) RS485 Serial Multi-Drop Communications

- h. 1 (One) Local I/O port
 - i. 1 (One) Display Serial Communications Port
7. The PLC shall not require any specialized tools for removal of the unit. System components including PLC, power supplies, etc. shall be DIN rail mounted. Terminations shall be via plug in connectors facilitating quick field replacement.
 8. PLC's and associated I/O modules shall meet national and international safety standards including UL, CSA, CE, DNV and Zone 2 Rated. In addition to the safety standards PLC system components shall also meet IEEE-472 (ANSI C37.90) surge withstand and IEC68-2-6 Vibration standards.
 9. The PLC shall operate from a 10-30 VDC power source. A battery and charger as previously specified shall be supplied to power the master & remote unit during 120 Volt service power outage conditions.
 10. The PLC's shall have an operational temperature range of -40°C to 70°C (-40°F to 158°F) under relative humidity conditions of 5 to 95% non-condensing. Storage temperature range up to 85°C (185°F)

B. Software:

1. The PLC shall have a high performance open source software architecture that utilizes a true multitasking operating system running a combination of standard and specially designed for water and wastewater application software modules. The system provided shall utilize an integrated system approach providing a comprehensive common configuration tool for all components within the system including I/O, Processor, Communications, and Operator Interface Display. The architecture shall permit all system components to be configured, simulated, tested and downloaded from one terminal to all system components.
2. The operating system shall be multitasking and allow a minimum of two separate programs to run simultaneously without affecting each other.
3. To provide for and insure multiple source support, the PLC system shall utilize industry standard programming language certified by the PLC open committee for all five languages supported by the IEC 61131-3 standard including; Sequential Function Chart, Ladder Diagram, Structured Text, Instruction List and Function Block Diagram. All five languages must be included. Any one or a combination of the aforementioned programming languages can be used to implement the system strategy. The programming software must be Windows™ based and be able to operate on Windows™ 7, or 8 operating systems.

4. PLC's provided under this specification shall be capable of performing the necessary logic to control the system as previously defined. These capabilities shall include, but not be limited to the following:

a. Discrete input/output	j. Latch/unlatch relays
b. Analog input	k. Counters
c. Analog output	l. Comparators
d. Timers	m. Ladder logic
e. Pump Controller	n. FlowTotalization/Integration
f. Pump Alternation	o. Intrusion Detection
g. Mathematical Function Blocks	p. Time of Day Control w/Lockout
h. Stage Blocks	q. Ramp Blocks
i. Trending	r. Data Logging

5. PLC's shall be capable of performing diagnostic functions. CPUs shall continuously monitor the functionality of the system and record errors and specific system events. A diagnostic buffer shall retain fault and interrupt events.nt

6. Communications between the PLC and the Operator Interface shall be accomplished using standard off-the-shelf drivers allowing use of standard Windows DDE and or OPC software drivers. Communications between the Plant PLC and the existing Microcat master shall be via communications port (RS-232 (up to 115 Kbps).

7. Each PLC shall have memory protected built in historical archiving/data logging of system alarms & events and process variables. Data logger shall be able to log data based on time or an event. PLC shall have enough memory allocated to allow 200,000 time and date stamped discrete and/or analog values to be archived. The historical archive shall allow the oldest data to roll off the system as memory is used keeping the 200,000 most current data points available. Process point time stamping frequency shall be selectable within the configuration software. It shall be possible for the archived data to be exported in CSV format allowing use with standard spreadsheet and data base software applications.

8. Each PLC shall have built in web server capability allowing system information to be stored in a format that allows for easy access and viewing with standard Windows™ based browser. Each unit shall be furnished with built in O & M data associated with its specific site including; as a minimum, basic system information, panel layouts, wiring diagrams, material lists w/part numbers, and operational summary. This information shall be accessible locally or remotely.

C. I/O Systems:

1. The PLC system shall have I/O resources to support a wide variety of applications without needing to depend upon alternate technologies to meet

various system data requirements. Each PLC shall be supplied with the required I/O to meet the specified requirements and allow for a minimum of 100% spare capacity for future expansion. The PLC system shall be easily scaled from a stand alone unit capable of supporting up to 1,024 local, 1,024 remote I/O, and 10,000 Ethernet networked I/O points or one of 254 RTUs with a total system data handling capability of 50,000 points.

2. The PLC system shall support a wide variety of modular I/O with various configurations to permit the most efficient use of I/O hardware and panel space. I/O modules shall be available for local I/O (within control panel), remote I/O (RS-485 based distributed outside of the control panel) and Ethernet based I/O (Distributed I/O on high speed in plant network or wireless Ethernet). Each I/O module shall be DIN rail mounted, have compression wire type terminals capable of accepting 14 AWG wire, have wire identification markers and I/O wiring diagram. Each module shall include diagnostic LEDs indicating module operational and I/O status. Each I/O module shall be electrically isolated, meet IEEE-472 (ANSI C37.90) surge withstand certification, shall be removable under power and easily field replaced with a spare module requiring no software/hardware reconfiguration adjustments. Each module shall be safety keyed to insure proper installation. I/O modules shall permit installation and operation in hazardous locations as classified under UL, CSA Class 1, Div. 2, Groups A, B, C & D.
3. Local I/O modules shall be connected to the PLC by a dedicated high speed serial communications port and shall allow local networking of 128 I/O modules for a total of 1024 I/O points via 2 twisted shielded wire pairs separated by up to 50 Ft. Local I/O to PLC update time shall not exceed 150 mS.
4. Remote I/O modules shall be connected to the PLC by a dedicated high speed isolated serial communications port and shall allow networking of 32 I/O modules directly or with up to 4 gateway I/O expansion modules allow 128 I/O modules for a total of 1,024 I/O points via RS-485 multidrop communications network separated by up to 10,000 ft. Remote I/O modules shall support multiple communications protocols including Modbus ASCII and RTU allowing connection to any device supporting these protocols.
5. Ethernet I/O modules shall be connected to the PLC by on board Ethernet 10/100 BaseT connection port. Ethernet I/O modules shall support multiple communications including TCP/IP and Modbus ASCII and RTU allowing connection to any device supporting these protocols over standard Ethernet backplane.
6. Control Panels WSCP, FSCP and RCP PLCs shall be IntraLink LC3000 as manufactured by Evoqua /Primex Controls or pre-approved equal.

D. Operator Interface Terminal

1. An Operator Interface/Keyboard Display shall be supplied for the Plant PLC and is to be mounted on the door of the enclosure. Keypad/Display shall allow the Operator to view and modify system variables within the PLC. Keypad/Display shall be NEMA 4 rated, have 20 system/function keys with tactile feedback, and have a minimum of 64 x 128 pixels capable of displaying graphics and a minimum of 8 lines with 20 characters per line. The display shall be a high contrast backlit LCD display so that it is unaffected by a wide range of ambient light conditions.
2. Operator interface shall have sufficient performance to permit real time updates of system data and shall be capable of display update at least 3 times per second. Operator initiated screen change shall occur within 50 mSec. The display shall incorporate a power save feature that shuts down the display after 5 minutes of keyboard inactivity.
3. The system display shall be preconfigured to reflect system parameters. The display shall support a minimum of 50 customizable main level process system displays. These displays shall be configured with graphical and text based data for the specific application to meet system monitoring and process control needs. The display shall be easily navigated by using a simple menu type format branching down to sub menus/levels. The display shall allow an operator to return to the main level with a one step push button entry. All system data and parameters shall be security protected. The system shall employ a hierarchal security password system affording a minimum of three (3) levels of password protected access to the system.
4. The display system shall incorporate a basic trending package that shall allow sixty samples of time based data for a single discrete or analog based data point to be displayed. The system shall allow trend display of any data point in the system.
5. The display system shall be able to display current and historical alarms and events. Upon the occurrence of a new unacknowledged alarm, the display shall show the date and time and sound an audible tone indicating the presence of an unacknowledged alarm. Acknowledging the alarm via the display keyboard shall silence the audible tone. Subsequent alarms shall reactivate the alarm audible tone. Historical alarm and event information shall be viewable from the display with the last 1,000 alarms or events including date and time of alarm being available.
6. The Operator Interface shall provide locally viewable system diagnostics for the PLC system to permit an on site method of troubleshooting the system without the need for specialized tools or knowledge. Diagnostics indicating system processor and communication errors and CPU performance/loading shall be viewable when in this mode.

7. Unit shall be capable of displaying process variables, provide management and processing of status and fault messages, and provide process control using soft keys, function keys or system keys. Keypad/Display programming shall be via Microsoft Windows based software as described above in the software section of this specification.

E. Communications:

1. For future connection of the new Control Panel WSCP to the Existing SCADA system, the PLC shall utilize Primex Controls standard communications protocol.
2. The telemetry system must be able to simultaneously support multiple communications protocols. The system supplied, as a minimum shall be able to supply Primex Controls“open” and Modbus RTU/ASCII (Remote/Slave) output data via RS-232, 485 & Ethernet format thus insuring a primary means of interfacing with non-related equipment.
3. The PLC system shall allow telemetry operations over multiple (LAN/WAN) communication media affording the most efficient and reliable solution including; DC metallic wire pair, dedicated leased voice grade phone line, standard dial up phone line, wireless cellular dial up system, cable TV, fiber optics, ethernet 10/100 BaseT, VHF Radio, UHF Radio, Dedicated Microwave Radio, and Ethernet Wireless. System communication architecture can be based on any one or a combination of these media. The communications speed shall be set to the highest speed allowed by the selected media.
4. The system shall support multiple modes of telemetry operation allowing highest possible system reliability and real-time response including; standard polling cycles, peer-to-peer, quiescent (Report on exception), store and forward (Repeater). System communication architecture can be based on any one or a combination of these modes of operation.
5. The PLC telemetry system shall employ a high level, efficient, secure communications protocol for future communications between Master Telemetry Unit (MTU) and Remote Telemetry Unit(s) (RTU). As a minimum the telemetry system shall utilize BCH, CRC16 or other high level error detection/rejection protocol to ensure true transmission/reception of data. Systems utilizing communications protocols with less capable error detection/rejection capabilities shall not be suitable for this application and will be summarily rejected.
6. The PLC system shall allow local or remote configuration or RTU troubleshooting without the need to be onsite. The system protocol shall support remote upload and down load file transfers between the master unit and associated RTUs. File transfer function shall provide reliable means of remotely transferring RTU configuration files so that any RTU configuration can be uploaded through the selected telemetry communications media to the online PC via the MTU, modified and then downloaded to the RTU. The

system shall support transfer of RTU historical files for recovery of historical data stored at each RTU in the event of communication or MTU failure. Historical files can be reassembled at the MTU/PC so that no loss of data occurs due to temporary communications interruptions. The Main PLC shall be supplied with a standard dial up modem allowing remote system access for factory service and technical support

F. Control Enclosures

1. Enclosures shall be NEMA Type 12, fabricated from a minimum of 14 gauge cold rolled steel with a baked enamel finish in the manufacturer's standard color. Units shall include a single gasketed front door. Full height hinges, locking hasp and door clamping hardware shall be included. All enclosures shall be UL listed.
2. Controls shall operate from a source of 120 volts, 1 phase, 60 Hz. All controls shall be protected from lightning or other transient voltages by a surge arrestor.
3. Condensation protection shall be provided. Enclosure shall have a heater which operates continuously to prevent condensation build-up.
4. All power supplies required for operation shall be provided. Power supplies shall be sized to have a minimum of 40% spare capacity providing increased reliability and allowing for the addition of future equipment.
5. All wiring shall be in complete conformance with the National Electric Code, state, local and NEMA electrical standards. All incoming and outgoing wires shall be connected to numbered terminal blocks and all wiring neatly tied and fastened to chassis as required. For ease of servicing and maintenance, all wiring shall be color coded and uniquely numbered. The wire color code and number shall be clearly shown on the drawings, with each wire's color and number indicated.
6. Panels provided under this section shall be constructed in compliance with Underwriter's Laboratories Inc. category 508A standards - Enclosed Industrial Control Panels listing and following-up. The control panel(s) shall bear the Underwriter's Laboratories serialized label for "Enclosed Industrial Control Panel".
7. While the use of U.L. listed components is encouraged, their use alone will not be considered an acceptable or satisfactory alternate to the "Enclosed Industrial Control Panel" serialized label specified above. Upon request from the Engineer, the panel manufacturer shall supply documentation to the Owner proving they are a U.L. recognized manufacturing facility for the type of equipment required. Only the labeled products of U.L.508A/"Enclosed Industrial Control Panel" recognized panel manufacturer shall be considered acceptable for use on this project.

G. Battery Back Up System

1. Included with Control Panels WSCP, FSCP and RCP, and working in conjunction with their DC power supply, shall be an intelligent battery back up system including voltage converter, battery health logic module, charger and sufficiently sized battery. Battery system shall provide a seamless switchover to battery upon detection of main DC power supply failure. Once the main DC power is restored, the unit shall provide seamless switchback to normal DC power source and recharge the battery. Battery health logic module shall individually monitor main DC power supply, battery and converter voltages for low voltage conditions, and provide low voltage cutoff to protect battery from an unrecoverable depletion. An on board LED, or local Operator Interface Terminal (OIT) if provided shall locally indicate detection of an alarm condition. In addition to local indication, all battery health and voltage information shall be displayed in the Master PLC for monitoring and alarm detection.
2. Battery system shall be of sufficient capacity to provide a minimum of four (4) hours of backup in the event of a failure of the main power source. To avoid battery damage and erroneous data transmissions when operating on battery, should the battery voltage drop below 10.8 V, the PLC shall be inhibited from operation. Recovery shall be automatic upon restoration of normal power. The intelligent battery back up system shall be able to source 5 Amps allowing operation of mission critical components including; sensors, local alarm and communication equipment during a power failure condition.

H. Spare Parts

As part of this contract, the Contractor shall furnish a minimum of one (1) each of the following spare parts: PLC module, Input/Output modules (one each type), PLC power supply module, communications module/modem and radio transceiver. Parts shall be provided in a single package with each component tagged.

2.3 NETWORK EQUIPMENT AND MATERIALS

A. Fiber Optic Cable: Multimode in Underground Direct-Buried

1. Fiber Type: 62.5 μ m multimode (OM1)
2. Number of Fibers per Cable: 4
3. Type of Cable: Loose-tube, gel-free, single-jacket, steel-armored, all-dielectric, for direct-buried outdoor installation.
4. Corrugated steel tape armor and UV-resistant, polyethylene outer jacket.
5. Fiber Coloring: Blue, Orange, Green, Brown, Slate, White

6. Design and Test Criteria: ANSI/ICEA S-87-640
7. Fiber Operating Wavelength: 850 nm / 1300 nm
8. Maximum Attenuation: 3.4 dB/km / 1.0 dB/km
9. Manufacturer: Corning ALTOS or approved equal.

B. Fiber Optic Cable Patch Panel

1. Surface Mount Fiber Wall Cabinet
2. Low-profile cabinets with front cover extending past the connector field on the user side of the panel to provide full patch cord protection.
3. Connection Type: LC
4. Ortronics Surface Mount Cabinet, OR-615SMFC series, no or equals allowed.

C. Fiber Optic Connectors

1. LC, multimode type.
2. Ortronics OptiMo Field-Installable Anaerobic fiber connectors, no or equals allowed.

D. Fiber / Ethernet Switches

1. Entry-Level Industrial Ethernet Rail-Switch, store and forward switching mode, Ethernet (10 Mbit/s) and Fast Ethernet (100 Mbit/s)
2. Ports:
 - a. (2) LC 100BASE-FX, MM Cable Fiber ports
 - b. (8) RJ-45 10/100Mbps copper ports.
 - c. VLAN support
3. Standards: IEEE 802.3, IEEE 802.3u
4. CE Approved
5. Switching method: Store and Forward
6. Power: 120VAC; 60Hz. autosensing
7. Temperature Rating:
 - a. Storage: -40 to +85° C

- b. Long-term operating: -40 to +70°C
 - 8. Humidity: 10–95%, noncondensing
 - 9. Size: 33mm H x 138mm W x 121mm D
 - 10. Hirschmann Series Fiber/Copper Ethernet switches, no or equals allowed.
- E. Fiber optic patch cords shall be factory assembled multifiber cables with the following features:
 - 1. Plug-to-socket design with ceramic 0.3 dB loss SC connectors as required for the specific application.
 - 2. Made with high strength 62.5 µm multimode fiber requiring a minimum bend diameter of one inch.
 - 3. Available in factory made lengths from 1 meter to 30 meters. Each patch cord provided shall be as required for the installation with at least 1 meter of slack cable after installation.
 - 4. Fiber optic patch cords shall be OptiMo Duplex, Multimode, 62.5-Micron Fiber Optic Patch Cables, or approved equal.
- F. Cat-5 Patch Cables
 - 1. Shielded twisted pair (STP) cables shall be high performance 4-pair cables with protective foil shielding specifically designed for Ethernet applications, verified to EIA/TIA Category 5e, with snagless boot and factory installed RJ-45 connectors.
 - 2. Cat-5 Patch Cables shall be Black Box CAT5e Shielded Twisted-Pair (STP) Patch Cables, or approved equal.

PART 3 FUNCTIONAL DESCRIPTION

3.1 General Configuration Conditions

- A. The existing Water Plant Control System (WPCS) is being upgraded with new control panels.
 - 1. Portions of the existing WPCS are to remain as currently configured. This includes, but is not limited to the following:
 - a. All Water Well controls
 - b. Power distribution system alarms
 - c. Carbon Column controls

2. The new Water System Control Panel (WSCP) shall communicate with the existing WPCS via an Ethernet connection. The WPCS shall remain the master control station with communications to the City of Dover central monitoring facility.
 3. All data contained in the new Control Panels shall be available to the existing WPCS and the central monitoring facility.
- B. The contractor shall be responsible for the configuration of the new Water System Control Panel (WSCP), the Filter System Control Panel (FSCP) and the Residuals Control Panel (RCP) as required to operate the Water Treatment processes as shown on project drawings and as detailed in the project specifications.
- C. Configuration of the existing WPCS shall be performed by others. The I/O remaining on the existing WPCS is to be moved to the new Control Panel WSCP in the future. Control Panel WSCP shall be provided with suitable space for future addition of these I/O signals.
- D. The operator shall be able to view and operate the new process from any of the three (3) new Control Panels.
- E. All analog inputs shall be scaled to appropriate engineering units for display on the Control Panel Operator Interface Terminals (OIT).
- F. The system shall calculate and display weekly, daily and hourly averages of all flows monitored. Calculate the daily minimum value, daily maximum value, daily average value and hourly average value. This information shall be stored within the software and be retrievable for the lifetime of the equipment.
- G. All set points shall be operator adjustable from the Control Panel OIT's.
- H. Alarms
1. Configure all discrete and analog alarms as detailed in the system Functional Description.
 2. All alarms shall be time and date stamped.
 3. All alarms may be viewed and acknowledged from any of the three (3) new Control Panel OIT's.
 4. All alarm conditions shall be latched. Alarms and associated interlocks must be manually reset through the Control Panel OIT's. Alarms shall not disappear from the alarm summary screen until the underlying condition is cleared.
 5. A time delay shall be provided on all digital input alarm signals. The time delay shall be adjustable and have a default value of zero seconds.

6. All analog signals shall be configured with Low-Low, Low, High and High-High alarm set points. Alarms shall be turned off except as detailed in the individual functional description statements.
7. All analog inputs shall be configured with “Under Range” and “Over Range” alarms.
8. All alarms shall be assigned a priority. The priorities are Critical, Warning and Log.
 - a. Critical alarms shall immediately transmit an alarm to the existing WPCS. Any alarm that causes an interlock condition shall be classified as Critical. Supervisors shall be capable of enabling/disabling the alarm transmission function completely or during defined and adjustable times of day.
 - b. Warning alarms will be annunciated on the OIT’s, but will not transmit the alarm to the WPCS.
 - c. Log alarms will not be annunciated on the OITs, but will be stored for record purposes.
 - d. All alarms shall be configured for one of these alarm types. Alarm types shall include at a minimum the following:

Alarm Type	Description	Priority
1.	Motor Fail to Start	Critical
2.	Motor Fail While Running	Critical
3.	Motor Overload / Drive Failure	Critical
4.	Process Value Low-Low Level Alarm	Critical
5.	Process Value Low Level Alarm	Warning
6.	Process Value High Level Alarm	Warning
7.	Process Value High-High Level Alarm	Critical
8.	High Pressure Alarm	Critical

- e. Miscellaneous Alarms – configure the following miscellaneous alarms that are not readily classifiable into one of the above alarm types:

Alarm	Description	Priority
1.	Ethernet Switch Failure	Critical
2.	Communications Failure	Critical
3.	Ethernet Switch Diagnostic	Critical
4.	Flooded Floor Alarm	Critical

- I. System Security – The system shall be configured with the following minimum number of user classes with the associated privilege levels. All users must be assigned to one of the following groups:

Group	Privilege
Guest	View and navigate between screens
Operator	View and navigate between screens Control of pumps, blowers, mixers (Manual/Automatic, Start/Stop) Control of Pressure and Level loops (Loop Mode, Setpoint, Output) Access to trending screens.
Supervisor	All of the above and Access to Loop tuning parameters
Administrator	User configuration

J. Motor Control

1. The OIT's shall display the following control devices for each motor:
 - a. Manual/Automatic selector switch
 - b. Start/Stop pushbutton
 - c. Speed Controller (for variable frequency drives only)
 - d. Running indicator
 - e. Motor Controller "In Automatic Mode" indicator
 - f. Drive Fault/Starter Overload indicator
 - g. Elapsed Time indicator
2. With the OIT Manual/Automatic selector switch in the Automatic position, the motor shall respond to Run Command signals from Control Panel WSCP. In the Manual position, the device will not be available for automatic control and the operator will be able to start and stop the device and, where appropriate, control motor speed.
3. Each motor starter/drive shall be provided with a Hand/Off/Auto selector switch. Control Panel WSCP shall monitor a contact from this switch and shall illuminate a Motor Controller In Automatic Mode indicator when the motor controller is set in the Auto position. When this signal is not present, the motor shall be considered not available for Control Panel WSCP operation.
4. Each motor shall be configured with the following alarms:
 - a. "Fail to Start" is declared if the feedback "Running" signal is not received within 10 seconds (adjustable) after the "Run Command" signal is sent.

- b. “Fail While Running” is declared if the feedback “Running” signal is lost after having been established, while the “Run Command” is still active.
 - c. If a standby machine is available, the Run Command shall be transferred to the alternate/standby machine.
5. Provide runtime indication for all motors. A set point shall be placed on the elapsed time which will illuminate an indicator advising the operator that the associated equipment has operated for the prescribed time period and is in need of required maintenance. The time period for selection shall be in increments of 100 hours. The specific time period and the resetting of the indicator shall require input at the Supervisor security level. This information shall be stored within the software and be retrievable for the lifetime of the equipment.

3.2 Existing Well Controls

The existing wells are controlled by the existing WPCS. As the water distribution system requires water, the existing controls start and stop the water well pumps as set by the operator at the WPCS. This control system shall remain unchanged.

3.3 Water System Control Panel (WSCP)

- A. As water begins to flow into the Treatment Plant, the water flow shall be detected by the Influent Flowmeter. Control Panel WSCP shall monitor the Influent Flowmeter and shall display the value graphically and digitally.
 1. A Low Flow set point shall be placed on this signal as a Permissive Interlock. As the water flow rises above this set point, various parts of the treatment process shall start or be made available to operate as detailed below.
 2. When water flow is off or below the Low Flow set point, the OIT screens shall display a No Influent Flow indication and all process Permissive Interlocks shall shut the process down.
- B. Control Panel WSCP shall monitor the Influent Flow Switch as a redundant Influent Flow Permissive Interlock. Activation of this switch shall permit the various parts of the treatment process to start or be made available to operate as detailed below.
 1. When water flow is off or below the switch set point, the OIT screens shall display a No Influent Flow indication and all process Permissive Interlocks shall shut the process down.
- C. The Mix Tank 1 Mixer
 1. Upon the clearing of the two (2) Influent Flow Permissive interlocks, the Mixer shall start and run at 75% speed (operator adjustable).

2. With the OIT Manual/Automatic selector switch in the Automatic position, the operator may adjust the speed from the OIT screen. With the selector switch in the Manual position, the operator may adjust the speed with the speed potentiometer at the motor.
 3. On the loss of one or both of the Influent Flow Permissive interlocks, the Mixer shall continue to run for a time delay period of 30 minutes (operator adjustable) before shutting down.
- D. The Pre-Lime System has its own vendor supplied control system for delivering lime powder and dispensing lime into the Slurry Tank 1. See rawing E-08.
1. Operation of the Vacuum Blower, Receiver Rotary Valve, Volumetric Feeder 3, the Slurry Tank Mixer and the Water Panel shall be controlled by Control Panel LSCP B.
 2. Upon the clearing of the two (2) Influent Flow Permissive interlocks, the Pre-Lime System shall start and run as required by Control Panel LSCP B.
 3. The amount of lime slurry that is dispensed into Mix Tank 1 is controlled by the amount of lime that is fed into Slurry Tank 1. A Manual/Automatic selector switch shall be provided on the OIT screen for Pre-Lime Feeder speed.
 - a. With the selector switch in the Automatic position, Control Panel LSCP B shall receive a Run Speed pacing signal from Control Panel WSCP paced to the Pressure Filter Influent pH Analyzer (see below).
 - b. With the selector switch in the Manual position, the operator shall be able to adjust the Pre-Lime System speed at LSCP B.
- E. Control Panel WSCP shall monitor the two (2) Intermediate Wet Well Level Transmitter signals and shall display both values graphically and digitally.
1. These transmitters are a redundant pair. A means shall be provided on the OIT screen for selecting one transmitter as the controlling signal and the second transmitter shall be a standby unit.
 - a. An indicator shall be provided showing which signal is being used for control.
 - b. Failure of the active transmitter signal shall signal an Instrument Failure alarm and automatically change to the standby unit for the control signal.
 - c. Control Panel WSCP shall provide a Run Speed signal paced to the Wet Well Level Transmitter signal for control of the Intermediate Pumps.
 2. High-High, High, Low and Low-Low Level set points shall be placed on this signal for control of the Intermediate Pumps.

- a. On a rise of water to the Control Level set point, the Lead Intermediate Pump shall be started at 75% speed (45 Hz). The Lead Pump speed shall be automatically adjusted to maintain the level at the pacing set point.
 - b. On a fall of water to the Low Level set point, the Lead Intermediate Pump shall be stopped.
 - c. With the Lead Intermediate Pump running, on a rise of water to the High Level set point, the Lag Intermediate Pump shall be started. The speed of both the Lead and Lag Pumps shall be automatically adjusted to maintain the pacing set point.
 - d. With both Lead and Lag Intermediate Pumps running, if the level falls below the Control Level set point, the Lag Intermediate Pump shall be shut down and the speed of the Lead Intermediate Pump shall be adjusted to maintain the pacing set point.
 - e. With both Lead and Lag Intermediate Pumps running, if the water level rises to the High-High Level set point, both Lead and Lag Intermediate Pumps shall be operating at full speed and an Intermediate Wet Well High-High Level alarm shall be signaled.
 - f. If the water level falls to the Low-Low Level set point, a Low-Low Intermediate Wet Well Level alarm shall be sounded and all Intermediate Pumps shall be shut down.
3. After shutting all of the Intermediate Pumps down, the Lead/Lag/Standby status for the Intermediate Pumps shall be rotated to equalize the operating time on all three Intermediate Pumps.
 4. As stated above, if the motor controller Hand/Off/Automatic selector switch for one of the Intermediate Pumps is not in the Automatic position, Control Panel WSCP shall operate the two remaining pumps as Lead and Lag.
- F. Control Panel WSCP shall monitor the Intermediate Pump Discharge Pressure Transmitter and display the value graphically and digitally.
1. A High Pressure set point shall be placed on this signal. Activation of this set point shall signal a High Discharge Pressure alarm and shall shut down the Intermediate Pumps.
- G. A water sample pump and pH Analyzer are existing to monitor the pH of the water flowing in the Chlorine Contact Tank. Control Panel WSCP shall monitor this signal and shall display the value graphically and digitally.
1. Control Panel WSCP shall provide a Run Speed signal paced to the Chlorine Contact Tank pH Analyzer signal for control of lime flow into the Slurry Mix Tank 2.

- H. The Post-Lime System has its own vendor supplied control system for delivering lime powder and dispensing lime into Slurry Tank 2. See drawing E-08.
1. Operation of the Lime Silo, Rotary Valve, Day Bin, Rotary Valve, Splitter Valve, Volumetric Feeders 1 and 2 and Slurry Tank 2 Mixer and the Water Panel shall be controlled by Control Panel LSCP A.
 2. Upon receipt of at least one Intermediate Pump Running signal by Control Panel WSCP, the Post-Lime System shall be enabled and shall run as required by Control Panel LSCP B.
 3. The amount of lime slurry that is dispensed into Mix Tank 2 is controlled by the amount of lime that is fed into Slurry Tank 2. A Manual/Automatic selector switch shall be provided on the OIT screen for Post-Lime Feeder speed.
 - a. With the selector switch in the Automatic position, Control Panel LSCP A shall receive a Run Speed signal from a Speed Control on the OIT screen.
 - b. With the selector switch in the Manual position, the operator shall be able to adjust the Pre-Lime System speed at LSCP A.
- I. Control Panel WSCP shall monitor the two (2) High Duty Wet Well Level Transmitter signals and shall display both values graphically and digitally.
1. These transmitters are a redundant pair. A means shall be provided on the OIT screen for selecting one transmitter as the controlling signal and the second transmitter shall be a standby unit.
 - a. An indicator shall be provided showing which signal is being used for control.
 - b. Failure of the active transmitter signal shall signal an Instrument Failure alarm and automatically change to the standby unit for the control signal.
 - c. Control Panel WSCP shall provide a Run Speed signal paced to the Wet Well Level Transmitter signal for control of the High Duty Pumps.
 2. High-High, High, Low and Low-Low Level set points shall be placed on this signal for control of the High Duty Pumps.
 - a. On a rise of water to the Control Level set point, the Lead High Duty Pump shall be started at 75% speed (45 Hz). The Lead Pump speed shall be automatically adjusted to maintain the level at the pacing set point.
 - b. On a fall of water to the Low Level set point, the Lead High Duty Pump shall be stopped.

- c. With the Lead High Duty Pump running, on a rise of water to the High Level set point, the Lag High Duty Pump shall be started. The speed of both the Lead and Lag Pumps shall be automatically adjusted to maintain the level at the pacing set point.
 - d. With both Lead and Lag High Duty Pumps running, if the level falls below the Control Level set point, the Lag High Duty Pump shall be shut down and the speed of the Lead High Duty Pump shall be adjusted to maintain the level at the pacing set point.
 - e. With both Lead and Lag High Duty Pumps running, if the water level rises to the High-High Level set point, both Lead and Lag High Duty Pumps shall be operating at full speed and an High Duty Wet Well High-High Level alarm shall be signaled.
 - f. If the water level falls to the Low-Low Level set point, a Low-Low High Duty Wet Well Level alarm shall be sounded and all High Duty Pumps shall be shut down.
- 3. After shutting all of the High Duty Pumps down, the Lead/Lag/Standby status for the High Duty Pumps shall be rotated to equalize the operating time on the three High Duty Pumps.
 - 4. As stated above, if the motor controller Hand/Off/Automatic selector switch for one of the High Duty Pumps is not in the Automatic position, Control Panel WSCP shall operate the two remaining pumps as Lead and Lag.
- J. Control Panel WSCP shall monitor the High Duty Pump Discharge Pressure Transmitter and display the value graphically and digitally.
 - 1. A High Pressure set point shall be placed on this signal. Activation of this set point shall signal a High Discharge Pressure alarm and shall shut down the High Duty Pumps.
 - K. Control Panel WSCP shall monitor the High Duty Pump Discharge Flowmeter and display the value graphically and digitally.
 - L. Control Panel WSCP shall monitor the Treated Water Fluoride Analyzer signal and shall display the value graphically and digitally.
 - M. Control Panel WSCP shall monitor the Treated Water Chlorine Analyzer signal and shall display the value graphically and digitally.
 - N. Control Panel WSCP shall monitor the Treated Water Turbidity Analyzer signal and shall display the value graphically and digitally.
 - O. Control Panel WSCP shall monitor the Pre-Oxidation Chlorine Feed Pump Panel.

1. Upon the clearing of the two (2) Influent Flow Permissive interlocks, Control Panel WSCP shall send a Run Command signal to the Pre-Oxidation Chlorine Feed Pump Panel.
 2. Control Panel WSCP shall provide a Run Speed signal paced to the Filter Raw Water Chlorine Analyzer pacing signal.
 3. Control Panel WSCP shall monitor the Pre-Oxidation Chlorine Feed Pump Panel Running signal. Failure of Control Panel WSCP to receive this confirming Running signal within ten seconds (adjustable from 5 to 60 seconds) shall shut down the Pre-Oxidation Chlorine Feed Pump Panel and signal a Pre-Oxidation Chlorine Feed Pump Panel Trouble alarm.
 4. Control Panel WSCP shall monitor the Pre-Oxidation Chlorine Feed Pump Panel Common Alarm signal. Activation of this contact shall signal a Pre-Oxidation Chlorine Feed Pump Panel Fault alarm
- P. Control Panel WSCP shall monitor the Post-Disinfection Chlorine Feed Pump Panel.
1. Upon receipt of a High Duty Pump Running signal, Control Panel WSCP shall send a Run Command signal to the Post-Disinfection Chlorine Feed Pump Panel.
 2. Control Panel WSCP shall provide a Run Speed signal paced to the High Duty Pump Discharge Flowmeter pacing signal.
 3. Control Panel WSCP shall monitor the Post-Disinfection Chlorine Feed Pump Panel Running signal. Failure of Control Panel WSCP to receive this confirming Running signal within ten seconds (adjustable from 5 to 60 seconds) shall shut down the Post-Disinfection Chlorine Feed Pump Panel and signal a Post-Disinfection Chlorine Feed Pump Panel Fault alarm.
 4. Control Panel WSCP shall monitor the Post-Disinfection Chlorine Feed Pump Panel Common Alarm signal. Activation of this contact shall signal a Post-Disinfection Chlorine Feed Pump Panel Fault alarm
- Q. Control Panel WSCP shall monitor the Fluoride Feed Pump Panel.
1. Upon receipt of a High Duty Pump Running signal, Control Panel WSCP shall send a Run Command signal to the Fluoride Feed Pump Panel.
 2. Control Panel WSCP shall provide a Run Speed signal paced to the High Duty Pump Discharge Flowmeter pacing signal.
 3. Control Panel WSCP shall monitor the Fluoride Feed Pump Panel Running signal. Failure of Control Panel WSCP to receive this confirming Running

signal within ten seconds (adjustable from 5 to 60 seconds) shall shut down the Fluoride system and signal a Fluoride System Fault alarm.

4. Control Panel WSCP shall monitor the Fluoride Feed Pump Panel Common Alarm signal. Activation of this contact shall signal a Fluoride Feed Pump Panel Fault alarm

3.4 Pressure Filter System Control Panel (FSCP)

- A. The Pressure Filters are furnished with their own control panel. The vendors Filter Control Panel (VFCP) shall monitor and control the detailed operation of the two Filters, including normal filtering operation, backwashing, etc., per their system operating requirements.
- B. The FSCP shall monitor the output connections from the VFCP as follows
 1. Filter 1 Running
 2. Filter 1 In Backwash
 3. Filter 2 Running
 4. Filter 2 In Backwash
 5. VFCP Trouble Alarm
- C. Control Panel FSCP shall input the following signals into Control Panel VFCP:
 1. Permissive Run signal from the Influent Flowmeter
 2. Permissive Run signal from the Influent Flow Switch
 3. Hold Backwash signal from the Backwash Tank High-High Level
- D. Control Panel FSCP shall monitor the Filter Inlet Turbidity Analyzer and shall display the value graphically and digitally.
 1. A set point shall be placed on the Filter Inlet Turbidity signal for a High Turbidity Level alarm.
- E. An Inlet Flowmeter is provided for each Pressure Filter. The FSCP shall monitor both of the Filter Inlet Flowmeters and shall display both values graphically and digitally.
- F. The FSCP shall monitor the Filter Inlet Chlorine/pH Analyzer and shall display both values graphically and digitally.

1. A set point shall be placed on the Chlorine signal for a High Chlorine Level alarm.
 2. A set point shall be placed on the Chlorine signal for a Low Chlorine Level alarm.
 3. A set point shall be placed on the pH signal for a High pH Level alarm.
 4. A set point shall be placed on the pH signal for a Low pH Level alarm.
- G. A Turbidity Analyzer is provided on each Filter discharge. The FSCP shall monitor both of the Filter Discharge Turbidity Analyzers and shall display both values graphically and digitally.
1. A set point shall be placed on each Filter Discharge Turbidity signal for a corresponding High Turbidity Level alarm.
- H. The FSCP shall monitor the Backwash Water To Filter Flowmeter and shall display the value graphically and digitally.
- I. The FSCP shall monitor the Filter Discharge Pressure Transmitter and shall display the value graphically and digitally.
- J. The FSCP shall monitor the Flooded Floor Sensor. Activation of this switch shall signal a Filter Bldg Flooded Floor alarm.
- K. The FSCP shall sound the System Alarm Horn as required for alarms throughout the entire system.

3.4 Residuals Control Panel (RCP)

- A. The RCP shall monitor the Residuals Tank Level transmitter and shall display the value graphically and digitally
1. A High-High Level set point shall be placed on this signal. As water rises to this level, the RCP shall signal a High-High Level alarm and shall shut down the Residuals Pumps..
 2. A High Level set point shall be placed on this signal. As water rises to this level, the RCP shall signal a High Level alarm.
 3. A Low Level set point shall be placed on this signal.
 - a. As water rises above this level, the RCP shall send a Permissive Run signal to Mixers 1 and 2. Starting of the Mixers shall be a manual operation by the plant operators.

- b. As water falls below this level, the RCP shall signal a Low Level alarm and shall shut down Mixers 1 and 2.
 - c. A set point shall be placed on this signal for a Low-Low Level. As water falls to this level, the RCP shall signal a Low-Low Level alarm and shall shut down Mixers 1 and 2, the Residuals Pumps and the Polymer System.
4. The RCP shall monitor the Filter to Backwash Tank Flowmeter and shall display the value graphically and digitally.
- a. A Low Flow set point shall be placed on this signal for operation of the Recirculation Pumps (see below).
5. The RCP shall monitor the Backwash Tank Level transmitter and shall display the value graphically and digitally
- a. A set point shall be placed on this signal for a High-High Level. As water rises to this level, the RCP shall signal a High-High Level alarm and send a Hold Backwash signal to the VFCP. As the level falls below the High Level set point, the Hold Backwash interlock shall be removed permitting the Filter Backwash cycle to resume.
 - b. A set point shall be placed on this signal for a High Level. As water rises to this level, the RCP shall signal a High Level alarm.
 - c. Three (3) set points shall be placed on this signal for Low Levels 1, 2 and 3 corresponding to the decant pipe elevations. The Control Panel OIT shall provide a selector for Level 1, 2 or 3 to be selected by the operator to match the opened decant valve. As water falls below this level, the RCP shall shut down the Recirculation Pumps.
 - d. A set point shall be placed on this signal for a Low-Low Level. As water falls below this level, the RCP shall signal a Low-Low Level alarm and shall shut down the Recirculation Pumps.
 - e. As the water level rises above the Low Level set point, the RCP shall send a Permissive Run signal to the Recirculation Pumps.
6. Starting of the Recirculation Pumps is a manual operation by the plant operators.
- a. If the Recirculation Pumps are running and Control Panel FSCP receives a Filter In Backwash signal from Control Panel VFCP, Control Panel RCP shall stop the Recirculation Pumps.
 - b. If the Recirculation Pumps are Running and the Filter to Backwash Tank Flowmeter signal rises above the Low Flow set point (see above), Control Panel RCP shall stop the Recirculation Pumps.

- c. After the interlocks as described in a. and b. above are cleared, a time delay of 30 minutes (operator adjustable) shall start. At the end of the time delay, the Recirculation Pumps shall re-start automatically
- 7. Operation of the Residual Pumps is a manual operation by the plant operators.
 - a. If the Residuals Tank Level falls below the Low-Low Level set point the Residuals Pumps shall be shut down (as above).
- 8. Operation of the Polymer System is a manual operation by the plant operators.
 - a. If the Residuals Tank Level falls below the Low-Low Level set point the Polymer System shall be shut down (as above).
- 9. Operation of the Residual Tank Mixers 1 and 2 is a manual operation by the plant operators.
 - a. If the Residuals Tank Level falls below the Low-Low Level set point the Residuals Tank Mixers 1 and 2 shall be shut down (as above).
- 10. The RCP shall monitor the Flooded Floor Sensor. Activation of this switch shall signal a Residuals Bldg Flooded Floor alarm.
- 11. The RCP shall monitor the Sand Filter Sump High Level Switch. Activation of this switch shall signal a Sand Filter Sump High Level alarm.
- 12. The RCP shall sound the System Alarm Horn as required for alarms throughout the entire system.

3.5 INPUT/OUTPUT SIGNALS

Refer to Electrical Drawings

PART 4 EXECUTION

4.1 INSTALLATION

- A. The contractor shall install all control panels and all appurtenances in accordance with the project drawings.
- B. Routine preventative maintenance suggested or required by the manufacturer for the system components shall be performed by the contractor until the satisfactory completion of the Site Acceptance Test.
 - 1. All functions should be tested and proved by the contractor before the scheduled Site Acceptance Test.
 - 2. Upon installation of each control panel, testing shall be performed as detailed in the submitted Site Acceptance Test Procedure.

3. Deficiencies shall be resolved and fully retested as required to satisfactorily demonstrate correct operation
4. Test the communications system between Control Panels WSCP, FSCP and RCP. Verify proper functioning of the communication network and immunity to outside electrical noise interference.
5. Test all control panel I/O to verify operability and calibration.
6. Test each control panel power supply UPS in the event of loss of power.

4.2 FIBER OPTIC INSTALLATION

- A. Installer Qualifications: Cabling installer must have BICSI-certified RCDD personnel on staff.
- B. Installation Supervision: All fiber optic installation activity shall be under the direct responsible supervision of an RCDD who shall be present when fiber work is performed at the site.
- C. All fiber strands in a cable are to be terminated on connecting hardware at each end of the fiber optic cable.
- D. Installation is to comply with TIA/EIA-568-C.3.
 1. Test all optical fiber strands after termination. Use an OTDR to verify the lengths, overall loss values, and to locate any defects.
 2. Retain all test data, including the overall loss value measured for each strand, and include the results in the permanent maintenance record.

APPENDIX A

STATE OF DELAWARE PREVAILING WAGE RATES

DAVIS BACON WAGE RATES

STATE OF DELAWARE
DEPARTMENT OF LABOR
DIVISION OF INDUSTRIAL AFFAIRS
OFFICE OF LABOR LAW ENFORCEMENT
PHONE: (302) 451-3423

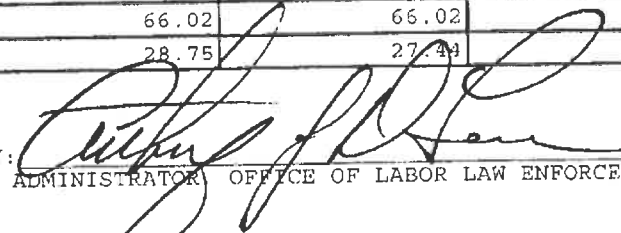
Mailing Address:
4425 North Market St. 3rd FL
Wilmington, DE 19802

Located at:
4425 North Market St. 3rd FL
Wilmington, DE 19802

PREVAILING WAGES FOR **BUILDING CONSTRUCTION** EFFECTIVE MARCH 15, 2017

CLASSIFICATION	NEW CASTLE	KENT	SUSSEX
ASBESTOS WORKERS	22.86	28.16	40.98
BOILERMAKERS	68.44	34.72	51.05
BRICKLAYERS	51.99	51.99	51.99
CARPENTERS	53.81	53.81	42.77
CEMENT FINISHERS	72.28	46.71	22.17
ELECTRICAL LINE WORKERS	45.47	38.99	29.73
ELECTRICIANS	66.85	66.85	66.85
ELEVATOR CONSTRUCTORS	90.49	64.49	31.94
GLAZIERS	71.20	71.20	56.66
INSULATORS	55.48	55.48	55.48
IRON WORKERS	62.85	62.85	62.85
LABORERS	44.70	44.70	44.70
MILLWRIGHTS	69.18	69.18	55.75
PAINTERS	48.47	48.47	48.47
PILEDRIVERS	75.27	39.35	31.83
PLASTERERS	29.84	29.84	22.12
PLUMBERS/PIPEFITTERS/STEAMFITTERS	65.95	51.49	57.01
POWER EQUIPMENT OPERATORS	67.29	67.29	43.83
ROOFERS-COMPOSITION	24.01	23.70	21.64
ROOFERS-SHINGLE/SLATE/TILE	18.39	21.86	17.19
SHEET METAL WORKERS	67.03	67.03	67.03
SOFT FLOOR LAYERS	51.12	51.12	51.12
SPRINKLER FITTERS	57.29	57.29	57.29
TERRAZZO/MARBLE/TILE FNRS	57.72	57.72	47.51
TERRAZZO/MARBLE/TILE STRS	66.02	66.02	55.02
TRUCK DRIVERS	28.75	27.44	20.94

CERTIFIED: 10/2/17

BY: 
ADMINISTRATOR, OFFICE OF LABOR LAW ENFORCEMENT

NOTE: THESE RATES ARE PROMULGATED AND ENFORCED PURSUANT TO THE PREVAILING WAGE REGULATIONS ADOPTED BY THE DEPARTMENT OF LABOR ON APRIL 3, 1992.

CLASSIFICATIONS OF WORKERS ARE DETERMINED BY THE DEPARTMENT OF LABOR. FOR ASSISTANCE IN CLASSIFYING WORKERS, OR FOR A COPY OF THE REGULATIONS OR CLASSIFICATIONS, PHONE (302) 761-8200

NON-REGISTERED APPRENTICES MUST BE PAID THE MECHANIC'S RATE.

PROJECT: WD1902 Water Treatment Plant Process Improvements , Kent County

PREVAILING WAGE DEBARMENT LIST

The following contractors have been debarred for violations of the prevailing wage law 29Del.C. §6960 or other applicable State statutes.

Therefore, no public construction contract in this State shall be bid on, awarded to, or received by contractors and individuals on this list for a period of (3) three years from the date of the judgment or as deemed by a court of competent jurisdiction.

Contractor	Address	Date of Debarment
Mullen Brothers, Inc. and Daniel Mullen, individually	3375 Garnett Road, Boothwyn, PA 19060	Indefinite/ Civil Contempt
MMR Associates DBA Peninsula Glass and Michael Rooney, individually	679 Horse Pond Road, Dover, DE 19901	1/20/2015
Site Work Safety Supplies, Inc. and Peter Coker, individually	4020 Seven Hickories Road Dover, DE 19904	1/12/2016
Green Granite and Jason Green, individually	604 Heatherbrooke Court Avondale, PA 19311	Indefinite/ Civil Contempt
Pro Image Landscaping, Inc. and Owner(s) individually	23 Commerce Street Wilmington, DE 19801 and/or 2 Cameo Road Claymont, DE 19703	Indefinite/19 Del.C. §108 & 10 Del.C. 542(c)
Liberty Mechanical, LLC and Owner(s), individually	2032 Duncan Road Wilmington, DE 19801	Indefinite/ 19 Del.C. 2374(f)
Integrated Mechanical and Fire Systems Inc. and Allison Sheldon, individually	4601 Governor Printz Boulevard Wilmington, DE 19809	Indefinite/19 Del.C. §108 & 10 Del.C. 542(c)

Updated: May 11, 2017

General Decision Number: DE170013 09/15/2017 DE13

Superseded General Decision Number: DE20160013

State: Delaware

Construction Type: Building

County: Kent County in Delaware.

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 \$10.20 for calendar year 2017 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 \$10.20 (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 2017. The EO minimum wage rate will be adjusted annually. Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/06/2017
1	01/20/2017
2	04/21/2017
3	05/26/2017
4	06/09/2017
5	06/16/2017
6	08/25/2017
7	09/15/2017

BOIL0013-009 01/01/2016

	Rates	Fringes
BOILERMAKER.....	\$ 42.26	37.02

BRDE0001-001 05/01/2017

	Rates	Fringes
BRICKLAYER		
Brick Refractory/Brick Placement Worker.....	\$ 32.51	22.41
Bricklayer.....	\$ 30.63	22.66

CARP0173-009 05/01/2016

	Rates	Fringes
CARPENTER (Includes Acoustical Ceiling Installation, Drywall Hanging, Form Work, Metal Stud Installation, Scaffold Building, Excludes Masonry/Brick, and Excludes Soft Floor Layer).....	\$ 31.37	22.19

CARP0251-008 05/01/2016

	Rates	Fringes
SOFT FLOOR LAYER.....	\$ 29.96	21.04

 CARP1906-003 07/01/2015

	Rates	Fringes
MILLWRIGHT.....	\$ 36.05	30.63

 ELEC0313-002 06/01/2016

	Rates	Fringes
ELECTRICIAN (Includes Low Voltage Wiring and Installation of Alarms, HVAC/Temperature Controls and Sound and Communication Systems).....	\$ 37.61	28.83

 ELEV0005-003 01/01/2016

	Rates	Fringes
ELEVATOR MECHANIC.....	\$ 52.79	29.985+A&B

FOOTNOTES FOR ELEVATOR MECHANICS:

A. PAID VACATION: Employer contributes 8% of basic hourly rate for 5 years or more of service or 6% for 6 months to 5 years of service.

B. Eight Paid Holidays (provided employee has worked 5 consecutive days before and the working day after the holiday): New Year's Day; Memorial Day; Independence Day; Labor Day; Veteran's Day; Thanksgiving Day and the Friday after Thanksgiving Day, and Christmas Day.

 ENGI0542-003 05/01/2017

	Rates	Fringes
POWER EQUIPMENT OPERATOR (Forklift).....	\$ 39.08	24.88+A

FOOTNOTE: A. PAID HOLIDAYS: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, Christmas Day, and Election Day (provided the employee works the scheduled work day following the holiday.)

 * IRON0451-003 07/01/2017

	Rates	Fringes
IRONWORKER (Ornamental and Reinforcing).....	\$ 33.60	30.10

The following holidays shall be observed, and when work is performed thereon it shall be paid for at twice the base wage rate: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day and Christmas Day.

LABO0199-005 05/01/2016

	Rates	Fringes
LABORER		
Backfiller, Common or General, Jack Hammer, Mason Tender - Brick, Pipelayer, Scaffold Builder (Brick and Masonry), Tamper (Hand Held).....	\$ 24.55	19.30
Mason Tender - Cement/Concrete.....	\$ 24.80	19.30

PAIN0252-002 05/01/2017

	Rates	Fringes
GLAZIER.....	\$ 41.30	28.06

PLAS0008-006 05/01/2017

	Rates	Fringes
PLASTERER (Fireproofers).....	\$ 37.42	28.83

PLAS0592-009 05/01/2017

	Rates	Fringes
CEMENT MASON/CONCRETE FINISHER...	\$ 30.79	24.58

PLUM0074-002 06/13/2016

	Rates	Fringes
PIPEFITTER (Includes HVAC Pipe Installation and Excludes Industrial Work).....	\$ 48.83	33.30

FOOTNOTE A: PAID HOLIDAYS: New Year's Day, Memorial Day, Independence Day, Thanksgiving Day, Labor Day, Christmas Day, and General Election Day.

PLUM0074-003 06/13/2016

	Rates	Fringes
PIPEFITTER (INDUSTRIAL).....	\$ 48.83	33.30

FOOTNOTE A: PAID HOLIDAYS: New Year's Day, Memorial Day, Independence Day, Thanksgiving Day, Labor Day, Christmas Day, and General Election Day.

SFDE0669-002 04/01/2017

	Rates	Fringes
SPRINKLER FITTER (Fire Sprinklers).....	\$ 35.35	21.69

SHEE0019-021 07/01/2017

Rates Fringes

SHEET METAL WORKER (Includes
HVAC Duct Installation).....\$ 31.31 36.01

SUDE2014-004 01/20/2016

	Rates	Fringes
IRONWORKER, STRUCTURAL.....	\$ 37.42	15.04
OPERATOR:		
Backhoe/Excavator/Trackhoe.....	\$ 47.71	8.41
OPERATOR: Bulldozer.....	\$ 25.89	0.00
OPERATOR: Crane.....	\$ 31.59	16.83
PAINTER (Brush and Roller).....	\$ 40.57	0.94
PLUMBER.....	\$ 45.40	16.23
ROOFER (Installation of Metal Roofs Only).....	\$ 39.09	30.77
ROOFER, Excludes Installation of Metal Roofs.....	\$ 27.98	27.90
TILE FINISHER.....	\$ 35.40	4.31
TILE SETTER.....	\$ 57.98	1.11

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:

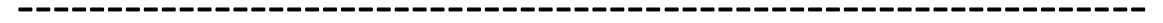
Administrative Review Board
 U.S. Department of Labor
 200 Constitution Avenue, N.W.
 Washington, DC 20210

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

=====

END OF GENERAL DECISION

APPENDIX B



GEOTECHNICAL INVESTIGATION LONG POINT WATER TREATMENT PLANT UPGRADES (AECOM)

R E P O R T

GEOTECHNICAL
INVESTIGATION
LONG POINT WATER
TREATMENT PLANT UPGRADES

DOVER, DELAWARE

Prepared for
City of Dover
Department of Public Works
P.O. Box 475
Dover, DE 19903

August 5, 2016



AECOM
625 W. Ridge Pike, Suite E100
Conshohocken, PA 19428
Tel: 610.832.3500
Fax: 610.832.3501

60436481



August 5, 2016
60436481

Mr. Jason A. Lyon, E.I.T.
Civil Engineer
City of Dover
Department of Public Works
P.O. Box 475
Dover, DE 19903

Subject: Report on Geotechnical Investigation
Long Point Water Treatment Plant Upgrades Project
Dover, Delaware

Dear Mr. Lyon,

We are pleased to present herein our report of a geotechnical investigation which was performed in connection with the proposed Long Point Water Treatment Plant Upgrade. This investigation was performed in accordance with our proposal dated January 5, 2016 (revised) and the Engineering Services Contract 14-0029PW, dated September 5, 2014.

Soil samples which were obtained during the investigation will be retained in our laboratory for a period of three months, after which they will be returned to you for proper disposal.

We sincerely appreciate the opportunity to be of service to you on this project. If you have any questions on the contents of this report, or if we may be of additional service, please give us a call.

Very truly yours,

Neil Scafonas, P.E.
Project Engineer

Kevin F. Martin, P.E.
Geotechnical Engineer

cc: Yongli Min, P.E., AECOM
John C. Volk, P.E., AECOM
Chris Curran, P.E., AECOM

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Plate 1	Regional Location Plan
Plate 2	Boring and DRI Location Plan

LIST OF APPENDICES

Appendix A	Subsurface Exploration
Appendix B	Laboratory Testing
Appendix C	Double Ring Infiltration Results

The Geotechnical Investigation reported herein was performed at the request of the City of Dover, in connection with the proposed design and construction upgrades for the Long Point Water Treatment Plant (WTP) Upgrade in Dover, Delaware. The project location is shown on Plate 1, Regional Location Plan.

The purpose of this investigation was to evaluate the geotechnical conditions at the site and to formulate conclusions and recommendations pertaining to the design and construction of the foundations for the proposed structure. Our services consisted of planning the investigation, a subsurface exploration program consisting of test borings, laboratory testing of representative soil samples, double ring infiltration (DRI) tests, engineering analysis of the data obtained, and preparation of this report.

A description of the subsurface exploration program and test boring logs are presented in Appendix A. The geotechnical laboratory testing program is described and the results are summarized in Appendix B. DRI results are presented in Appendix C. Relevant findings, conclusions, and recommendations derived from this investigation are presented in the following sections.

The Long Point WTP was designed in 1991 to supplement fourteen deep wells supplying water to the City of Dover. The water treatment processes include ozone disinfection, pH adjustment, granular activated carbon pressure filtration, iron sequestration, and secondary disinfection system. The existing WTP will be upgraded to increase capacity of treated water and improve the treatment process.

The proposed structures and equipment for the upgrade consist of sand beds, backwash processing tank, residuals tank, filter building and support tanks, and a driveway, as shown on Plate 2, Boring Location Plan. The backwash processing tank and residuals tank will have a foundation load on the order of 1,500 pounds per square foot (psf). It is understood that the finished grades will be more or less the same as the existing grades.

The site is located at 880 Long Point Road, Dover, Delaware. The sand beds, backwash processing tank, and residuals tank are located in the southern portion of the site. The filter building and tanks are located in the northern portion of the site. The terrain is relatively flat with a grass surface and trees lining the northern boundary of the site. The existing elevations at the site vary from El. 23.1 feet to El. 23.6 feet.

Based on a review of available geologic information, the site is underlain by the sediments of the Atlantic Coastal Plain. The Atlantic Coastal Plain consists of sediments, mostly silt, sand, and gravel, that have been eroded off the Piedmont and adjacent Appalachian Mountains.

The oldest Coastal Plain sediments observed in Delaware are river-deposited sediments. These sediments were eroded from the Appalachian Mountains to the west, transported to the southeast by rivers, and deposited where the rivers met the ocean to form a delta. On top of the river sediments, a sequence of marine silt and sand deposits records the rise and fall of the sea level many times during a period of over 80 million years, from the Late Cretaceous until the end of the Tertiary Period, about 2 million years ago.

On top of all of these sediments is a thin veneer of young sand and gravel that was carried into Delaware by glacial outwash during the Ice Age. Glacial ice did not advance into Delaware, but melt-water pouring off the glacier fronts carried great quantities of sand, silt, and gravel over southern Pennsylvania and Delaware.

References:

- 1) 2012 Delaware Geological Survey, University of Delaware, Newark, DE 19716-7501, <http://www.dgs.udel.edu/delaware-geology/summary-geologic-history-delaware>.

The subsurface conditions at the site were explored by means of four test borings as shown on Plate 2, Boring and DRI Location Plan. The borings were drilled to depths ranging from approximately 25 to 50 feet below the existing grades. In addition, two test pits were excavated to approximately 5 ft depth each for DRI testing. Logs of the test borings and test pits are presented in Appendix A, together with a description of the drilling and sampling methods. Geotechnical laboratory test results are presented in Appendix B. DRI test results are presented in Appendix C. The various strata encountered are described below:

4.1 TOPSOIL

Topsoil was encountered with a thickness ranging from approximately 2 to 18 inches in all borings and test pits. The topsoil consisted of dark brown silty clayey sand with organic matter.

4.2 STRATUM 1 – FILL

The fill was encountered below ground surface in Boring B-2 with a thickness of approximately 6 feet. The soils of this stratum generally consist of gray sand and gravel with trace silt. The standard penetration test (SPT) values ranged from 8 to 51 blows per foot (bpf), averaging 24 bpf, indicative of a medium dense to very dense condition.

4.3 STRATUM 2 – SILTY CLAY/ SILTY SAND

This stratum was encountered below Stratum 1 or below the ground surface in all borings to depths up to 50 feet. The borings were terminated within Stratum 2. The soils of this stratum generally consist of brown silty coarse to fine sand with trace gravel, and an interlayer of brown and gray silty clay. The SPT values ranged from 2 to 40 bpf, averaging 11 bpf, indicative a loose to medium dense condition. The pocket pen resistance (PPR) values on the fine grained soils ranged from 1.5 to 4.5 tons per square foot (tsf), indicative of a generally very stiff consistency.

Results of nine moisture content tests indicate that the moisture contents vary between 8.5 and 33.9 percent, averaging 19.3 percent. Results of eight grain size distribution tests indicate that there is an average of 3.8 percent gravel, 59.6 percent sand, and 36.6 percent fines. Grain size distribution curves are shown in Appendix B. Results of five Atterberg limit tests indicate liquid limits varying between non-plastic (NP) and 21 percent, averaging 23 percent and plastic limits varying between NP and 21 percent, averaging 13 percent.

One unconsolidated-undrained (UU) triaxial compression test indicates an undrained shear strength of 2,510 psf, indicative of a very stiff consistency. Results of one consolidation test indicate a preconsolidation pressure of 5.3 tsf, compression index of 0.12, and a recompression index of 0.02 (all strain based).

4.4 GROUNDWATER

Groundwater was not observed in the test borings due to the drilling method. However, saturated soils were encountered in all of the borings at depths of approximately 15 feet, indicating the possibility of the groundwater table. It should be noted that groundwater levels are subject to seasonal, tidal, and long-term variations due to climatic and man-made influences.

4.5 DOUBLE-RING INFILTRATION TESTS

Two DRI tests were performed, as shown on Plate 2. The results indicate an infiltration rate of less than 0.1 inches/hour.

5.1 FOUNDATIONS

Based on the test borings, the subsurface generally consists of a loose to medium dense sand with gravel and inter layers of very stiff silty clay.

The existing soils or structural fill should be capable of supporting shallow foundations with a maximum net bearing pressure of 2,000 psf. With this allowable bearing pressure, the total and differential settlement is not expected to exceed $\frac{3}{4}$ and $\frac{1}{2}$ inch, respectively. Majority of the estimated settlement is expected to occur rapidly following the construction.

5.2 GROUNDWATER CONTROL

Groundwater is not expected to be encountered during foundation construction. The contractor should be prepared to perform any temporary dewatering. Surface water due to precipitation should be channeled away from the construction area. Any accumulation of water in the excavation should be pumped out before concrete placement.

Recommendations pertaining to the design and construction of the foundations for the proposed structures are presented below.

6.1 SITE PREPARATION

Site preparation should consist of removing all vegetation and topsoil, and excavating the area to the subgrade level. Site clearing should extend at least 5 feet beyond the limits of proposed structures. Subsurface utilities in the areas of the proposed structures should either be re-routed or abandoned in place by filling with grout. Loose backfill or other unsuitable fill materials above and around existing utilities should be removed and replaced with structural fill.

All subgrade for the proposed buildings should be proof-rolled and compacted on grade, utilizing equipment that is acceptable to the Geotechnical Engineer. This may consist of a static drum compactor that imparts a static load of at least 500 pounds per inch drum width. Any loose or soft materials detected by proof-rolling that cannot be stabilized by additional compaction should be removed to stable material and replaced with structural fill, or otherwise as directed by the Geotechnical Engineer. The requirements for the structural fill are presented in Section 6.5.

6.2 FOUNDATIONS

Foundations for the support of the proposed structures may be supported on shallow spread footings, continuous wall footings, and/or mat foundations bearing on competent site soils or structural fill. The footings should be proportioned such that the combined dead and live load will not exceed a maximum net bearing pressure of 2,000 psf. The recommended bearing value may be increased by 33 percent for short-term loading such as wind and seismic loads. All spread and continuous footings should have a minimum width of 36 and 18 inches, respectively, regardless of the actual bearing pressures developed. All footings should be based a minimum of 2.5 feet below adjacent exterior finished grades for frost protection.

A modulus of subgrade reaction, K_{V1} for a 1 square foot bearing plate of 100 tons per cubic ft (tcf) should be used for design. To obtain the Modulus of Vertical Subgrade Reaction, K_b , use $K_b = K_{V1} [(b+1)/(2b)]^2$ where b = width of mat.

Foundation Construction: Foundation excavations should be protected from freezing and the accumulation of ponded water. Concrete should be placed as soon as the excavation is completed. All footing excavation surfaces should be protected until the concrete and backfill are placed. Footing bearing surfaces should be cleaned of all material loosened by the excavation process prior to concrete placement. Should loose or soft materials be encountered which cannot be densified by additional compaction, the loose or soft materials should be removed and replaced with lean concrete or compacted structural fill in accordance with Section 6.5 below.

If concrete can't be placed on the same day the excavation is made, it is recommended to place a 4-inch thick mud mat consisting of lean concrete over the exposed subgrade. This is to minimize potential disturbance to the soils due to wet and/or freezing weather during construction.

6.3 SLAB-ON-GRADE

Slabs-on-grade should be supported on the densified, granular on-site soils or structural fill. Prior to floor slab construction, all subgrades should be thoroughly proof-rolled with a smooth-

drum vibratory compactor that imparts a total applied force (static plus dynamic) of at least 500 pounds per inch of drum width. Any soft materials that cannot be densified by additional compaction should be removed and replaced with structural fill. Any materials that were loosened by previous construction activity or weather conditions should be re-compacted to the requirements described below in Section 6.5, Structural Fill.

To preclude floor dampness, a capillary break consisting of a compacted 4-inch thick layer of AASHTO No. 57 stone should be constructed beneath the floor slab. Additionally, a 10-mil polyethylene membrane or similarly rated vapor barrier should be placed over the capillary break after compaction.

6.4 SEISMIC DESIGN

Based on the 2012 edition of the International Building Code (IBC), the site soil classification is Site Class D.

6.5 STRUCTURAL FILL

Structural fill may be required for backfilling below the proposed structures and equipment and for replacement of unsuitable materials under loaded areas. Structural fill should consist of predominately granular soil or crushed stone with a maximum particle size of 2 inches, and not greater than 10 percent passing the No. 200 sieve, such as DelDOT Borrow Type G-1 or DelDOT Graded Aggregate Type "A" (CR-1). Any fine-grained soils from the excavation should not be used as structural fill.

Structural fill below the foundations should be placed in horizontal lifts with a loose thickness of not more than 9 inches. Structural fill should be compacted to an average of no less than 95 percent of the maximum dry density as determined in the laboratory by the "Modified Proctor" compaction test, ASTM D 1557, or not less than 80 percent of the relative density as determined by the "Maximum Index Density and Unit Weight of Soils Using a Vibratory Table" ASTM D 4253/4254 for free-draining fill materials. Structural fill should not be placed on wet, muddy, or frozen soils.

6.6 EARTH PRESSURES

The design of retaining walls that are restrained from movement should be based on the at-rest earth pressure. The earth pressure should be calculated assuming the backfill to be an equivalent fluid with a weight of 60 pcf. In addition, a uniform pressure equal to one-half of any surcharge pressure on the surface of the backfill should be added.

For unrestrained walls, the active earth pressure should have an equivalent fluid unit weight of 40 pcf, plus a surcharge coefficient of one-third.

For resistance to sliding, a coefficient of friction of 0.3 may be used at the base of the foundation. If passive resistance of the soil is utilized in the design, an equivalent fluid weight of 360 pcf may be used. A factor of safety of at least 2.0 should be provided against sliding.

6.7 EXCAVATION SLOPES

Temporary excavations above the groundwater level should have side slopes not steeper than 1.5H:1V. Pertinent OSHA and local regulations should be followed where they require flatter

side slopes than given above. Sheeting and shoring for excavations, if required, should be designed by an Engineer registered in the State of Delaware.

6.8 CONSTRUCTION MONITORING

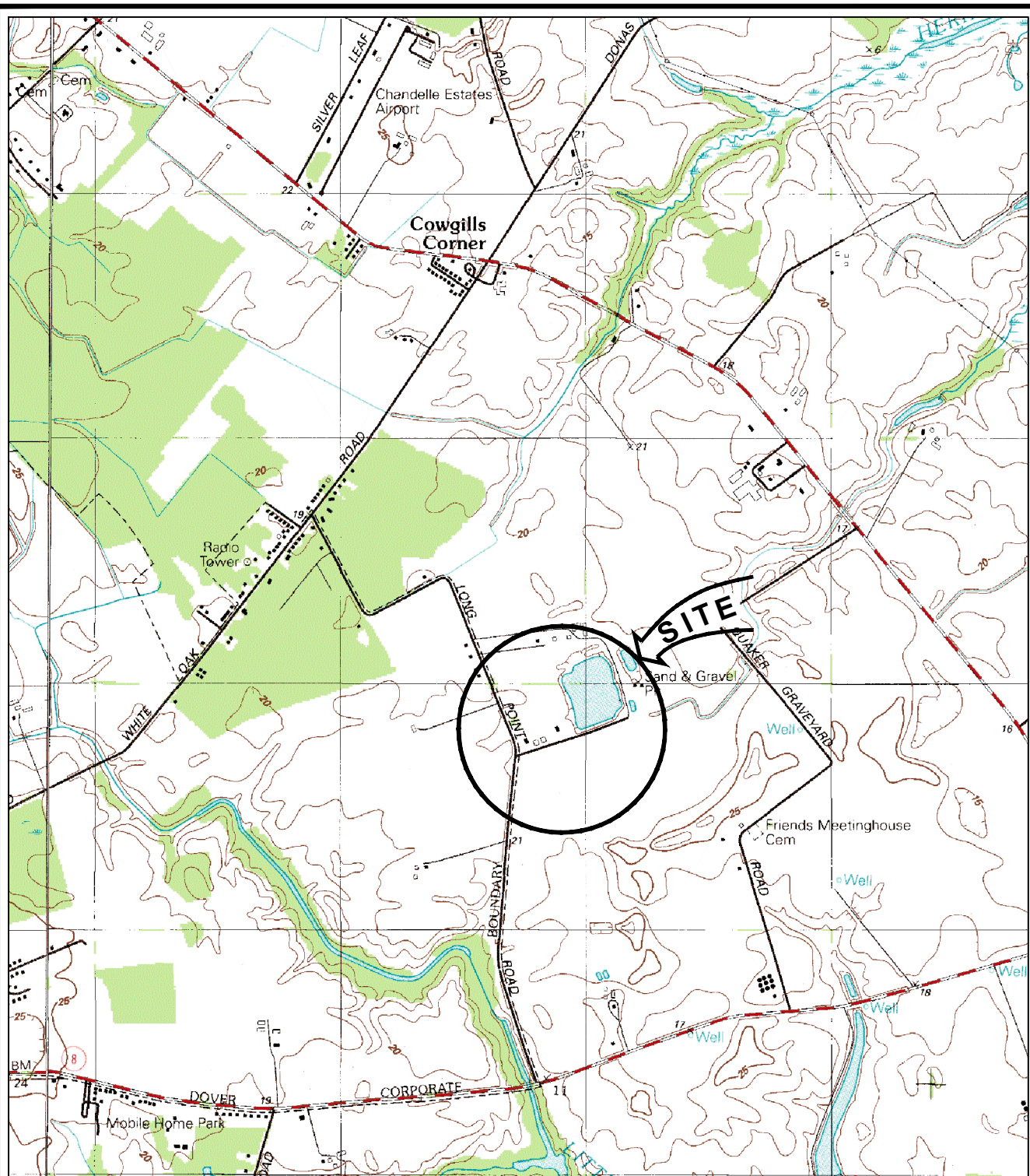
It is recommended that construction monitoring be provided full time during foundation construction by AECOM or an equally qualified geotechnical engineering firm that is familiar with the subsurface conditions and foundation design criteria. The items that should be observed, monitored, and/or tested include subgrade preparation, evaluation of foundations soils, suitability of compaction equipment, placement and compaction of structural fill, and backfill.

The services described in this report were provided in accordance with the standard of care. No warranty or guarantee, expressed or implied, is intended. The conclusions and recommendations are based on the assumptions that the subsurface conditions do not deviate appreciably from those revealed by the test borings drilled during this investigation, and that the loads are similar to those given in the project description. If the structures are moved or loads have changed, AECOM should be given the opportunity to modify recommendations accordingly. The conclusions and recommendations are also based on competent field engineering, monitoring, and testing during construction. The recommendations presented in this report are solely for the use of our client for the design of this particular project. Any re-use of this document, particularly by third parties, without the express written permission of AECOM is solely at their own risk.

Physical property tests were conducted in the laboratory on selected representative soil samples to aid in classification and for correlation with engineering behavior of the soils. These tests included natural water content (ASTM D 2216), grain-size distribution (ASTM D 422), liquid and plastic limits (ASTM D 4318), and unconfined compressive strength of rock (ASTM D 7012). Engineering property tests were conducted in the laboratory on relatively undisturbed Shelby tube samples. These tests included unconsolidated-undrained (UU) triaxial compression (ASTM D 2850) and consolidation (ASTM D 2435).

The numerical results are summarized on Page B-2 and are also shown on the appropriate boring logs. Grain-size distribution curves are presented on Pages B-3 through B-6. UU triaxial test results are presented on Page B-7, and consolidation test results are shown on Pages B-8 through B-14.

Plates



SCALE: 1 INCH=2000 FEET



MAP SOURCE
LITTLE CREEK, DE QUAD
U.S. GEOLOGICAL SURVEY, 1993

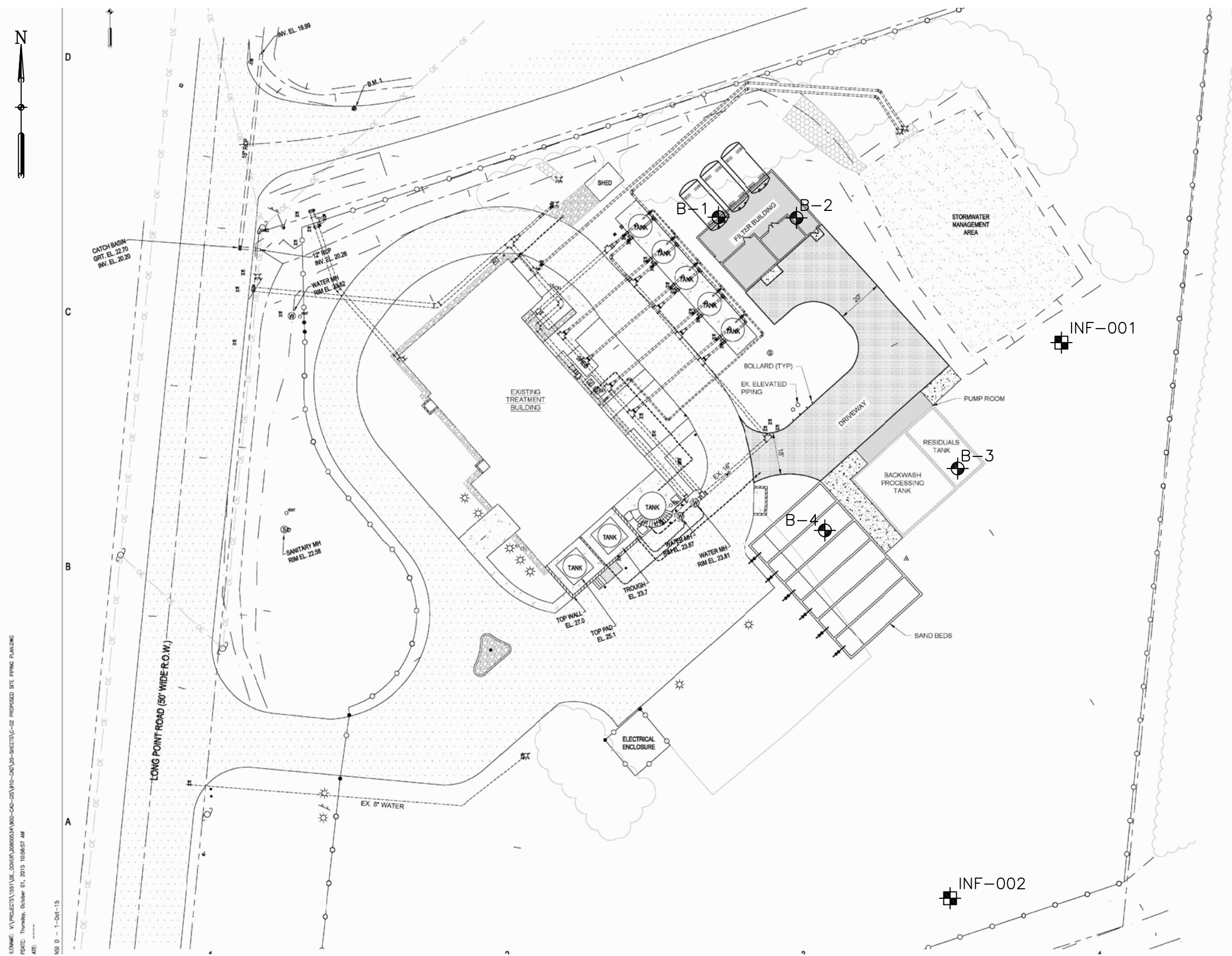


625 West Ridge Pike, Suite E-100
Conshohocken PA 19428
Direct: 610.832.3500 Fax: 610.832.3501

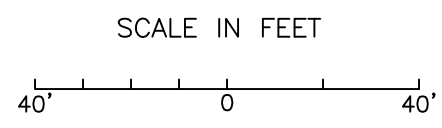
Job: 60436481
Prepared by: TFP
Checked by:
Date: 08/05/2016

REGIONAL LOCATION MAP
DOVER LONG POINT WATER TREATMENT PLANT
DOVER, DELAWARE

LOTNAME: V:\PROJECTS\1551\DEL_DOVER\200055A\900-CAD-050\110-000\20-SHEETS\C-02 PROPOSED SITE PIPING PLANING
 PDATE: Thursday, October 01, 2015 10:56:57 AM
 A/E: -----
 NSI D - 1-061-15



LEGEND:
 B-4 TEST BORING LOCATION
 INF-001 DRI LOCATION



AECOM
 625 WEST RIDGE PIKE, SUITE E-100
 CONSHOHOCKEN, PA 19428
 (610) 832-3500 FAX (610) 832-3501

Job: 60436481
 Prepared by: TFP
 Checked by:
 Date: 03/31/2016

BORING AND DRI LOCATION PLAN
 LONG PORT ROAD WATER TREATMENT PLANT
 CITY OF DOVER
 KENT COUNTY, DELAWARE

Appendix A
Subsurface Exploration

The subsurface exploration consisted of four test borings located as shown on Plate 2, Boring Location Plan. The borings were drilled between January 8 and 11, 2016, by Craig Test Boring Company Inc., located in Mays Landing, New Jersey. The test borings were conducted under full-time technical supervision of AECOM. The test borings were located in the field by AECOM. Boring locations are based on field measurements by AECOM. Ground surface elevations were estimated based on a topographic map (be specific).

The test borings were performed using a CME-75 truck mounted drilling rig and were advanced by mud rotary drilling techniques. Samples of the subsoils were recovered from the borings for identification and classification purposes by means of a 2-inch O.D. split-barrel sampler driven 24 inches by a 140-pound hammer freely falling 30 inches (the Standard Penetration Test, ASTM D 1586). The number of hammer blows required to drive the sampler during the interval from 6 to 18 inches, or fraction thereof, is reported on the test boring logs as the sampling resistance. Relatively undisturbed samples of fine-grained soils were recovered with a 3-inch O.D. thin-walled Shelby tube sampler in general accordance with ASTM D 1587.

Where fine-grained materials were encountered, pocket penetrometer resistance (PPR) readings were taken to obtain an indication of the unconfined compressive strength of cohesive soils. These values are shown on the boring logs under "Pocket Penetrometer (tsf)".

At the completion of the test borings, the boreholes were backfilled with auger cuttings mixed with bentonite/cement grout.

A "Key to Soil Symbols and Terms" used in this report is included on page A-2. The logs of the test borings in the final investigation are presented on Pages A-3 through A-10.

Major Divisions		Group symbols		Typical names		Laboratory classification criteria		Material		Particle Size		Unconfined Compression Strength, tons/sq. ft.	
Highly organic soils	(Liquid limit greater than 50)	Silt and clays	OH	Organic clays of medium to high plasticity, organic silts	Less than 5 per cent fines (More than half of coarse fraction is larger than No. 4 sieve size)	GM, GP, SW, SP	C _u = D ₆₀ /D ₁₀ greater than 4; C _c = (D ₃₀) ² /D ₁₀ D ₆₀ between 1 and 3	Sand	Fine	4.76 To 19.1	#4 To #20	0.074 To 0.42	2.00 To 4.76
Silt and clays	(Liquid limit less than 50)	ML, CL, OL	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	5 to 12 per cent fines (More than 5 per cent fines are classified as follows: GM, GP, SW, SP)	C _u = D ₆₀ /D ₁₀ greater than 6; C _c = (D ₃₀) ² /D ₁₀ D ₆₀ between 1 and 3	Gravel	Coarse	19.1 To 76.2	#10 To #60	0.075 To 4.75	4.75 To 20.0	
													Sample Recovered
Sands	(More than half of coarse fraction is smaller than No. 4 sieve size)	SM, SC	Silty sands, sand-silt mixtures	Clayey sands, sand-clay mixtures	Less than 5 per cent fines (More than half of coarse fraction is larger than No. 4 sieve size)	C _u = D ₆₀ /D ₁₀ greater than 4; C _c = (D ₃₀) ² /D ₁₀ D ₆₀ between 1 and 3	Sand	Fine	76.2 To 304.8	#20 To #100	0.425 To 0.850	0.850 To 2.00	
													Sample Recovered
Coarse-grained soils	(More than half of material is larger than No. 200 sieve size)	GW, GP	Well-graded gravels, gravel-sand mixtures, little or no fines	Poorly graded gravels, gravel-sand mixtures, little or no fines	5 to 12 per cent fines (More than 5 per cent fines are classified as follows: GM, GP, SW, SP)	C _u = D ₆₀ /D ₁₀ greater than 4; C _c = (D ₃₀) ² /D ₁₀ D ₆₀ between 1 and 3	Gravel	Coarse	304.8 To 2000.0	#20 To #100	0.850 To 4.75	4.75 To 20.0	
													Sample Recovered

KEY TO SOIL SYMBOLS AND TERMS

Terms used in this report for describing soils according to their texture or grain size distribution are in accordance with the Unified Soil Classification System, as described in Technical Memorandum No. 3-357, Waterways Experiment Station, March 1953.

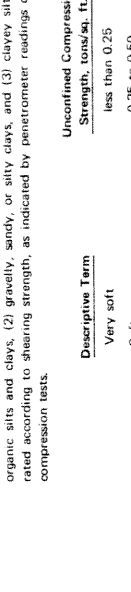
TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on No. 200 sieve): Includes (1) clean gravels and (2) silty or clayey gravels and sands. Condition is rated according to relative density⁽¹⁾ as determined by laboratory tests or standard penetration resistance tests.

Descriptive Term	Relative Density
Very loose	0 to 15%
Loose	15 to 35%
Medium dense	35 to 65%
Dense	65 to 85%
Very dense	85 to 100%

FINE GRAINED SOILS (major portion passing No. 200 sieve): Includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests.

Descriptive Term	Unconfined Compression Strength, tons/sq. ft.
Very soft	less than 0.25
Soft	0.25 to 0.50
Firm	0.50 to 1.00
Stiff	1.00 to 2.00
Very stiff	2.00 to 4.00
Hard	4.00 and higher



TEST AND SAMPLE IDENTIFICATION

15 - The number of blows (15) of a 140-pound hammer falling 30 inches used to drive a 2" O. D. split-barrel sampler for the last 12 inches of penetration.

50/2 - Number of blows (50) used to drive the split-barrel a certain number of inches (2).

P - Thin-wall tube sample.

P/250 - Thin-wall tube pushed hydraulically, using a certain pressure (250 psi) to push the last 6 inches.

C₁ - Denison or Pitcher-Type -- core-barrel sample.

Ps - Piston sample.

A - Auger sample.

BX - Rock cored with BX core barrel, which obtains a 1.5/8" diameter core.

NX - Rock cored with NX core barrel, which obtains a 2.1/8" diameter core.

65% - Percentage (65) of rock core recovered.

20% - Rock Quality Designation (RQD)(2).

VS - Vane Shear Test.

C - Consolidation and specific gravity tests.

D - Maximum & minimum density.

GS - Specific gravity test.

DS - Direct Shear test.

K - Permeability test.

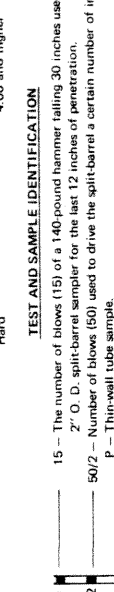
M - Mechanical (sieve or hydrometer) analysis.

T - Triaxial compression test.

U - Unconfined compression test.

W - Unit weight & natural moisture content.

X - Special tests performed -- see Laboratory test results.



Material

Gravel	4.76 To 19.1	#4 To #20	0.075 To 0.425
Cobbles	76.2 To 304.8	#20 To #100	0.425 To 4.75
Boulders	304.8 To 2000.0	#100 To #400	4.75 To 2000.0

Sample Recovered

Sample Recovered

Sample Not Recovered

* Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

** Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well-graded gravel-sand mixture with clay binder.

(1) ASTM 2009-69

(2) RQD >= Core Segments > 4 inches x 100 Core Interval

Where Segmentation is Not Caused By Drilling Effects

LOG of BORING No. B-1

DATE 1/11/16 SURFACE ELEVATION 23.2 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0				Topsoil (7 inches)	22.6					
6			SS	Medium dense to dense light brown silty coarse to fine SAND, trace gravel						
26			SS							
5			29	SS						
22			SS				8.5			M
21			SS							
10			7	SS		3.75 4.0	13.6	31	15	M
15			4	SS			19.9			M
20			4	SS						
25			7	SS	(Stratum 2)	-1.8				
				Notes: 1. Samples were observed to be wet at a depth of approximately 15 feet during drilling. 2. The borehole was offset approximately 5 ft east from the proposed location.						
30										
35										
40										

8/5/16 BORLOGR 80436481 LONG POINT WTP.GPJ

Completion Depth: 25.0 ft. Water Depth: See ft., After _____ hrs.
 Project No.: 60436481 Notes ft., After _____ hrs.
 Project Name: Long Point WTP _____ ft., After _____ hrs.
 Drilling Method: Mud Rotary _____ ft., After _____ hrs.

LOG of BORING No. B-2

DATE 1/11/16 SURFACE ELEVATION 23.2 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0				Topsoil (3 inches)	23.0					
8		51	SS	Medium dense to very dense gray SAND and GRAVEL, trace silt (Fill)						
5		12	SS	(Stratum 1)	17.2					
16			SS	Very stiff to hard gray and brown silty CLAY						
10		12	SS			4.50				
10		14	SS	Loose to medium dense brown silty coarse to fine SAND, trace gravel						
15		4	SS	- becoming light grayish brown coarse to fine sand, trace gravel and silt						
20		7	SS							
25		21	SS	- dense						
				(Stratum 2)	-1.8					
				Notes: 1. Samples were observed to be wet at a depth of approximately 15 feet during drilling.						

8/5/16 BORLOGR 80436481 LONG POINT WTP.GPJ

Completion Depth: 25.0 ft. Water Depth: See ft., After _____ hrs.
 Project No.: 60436481 Notes ft., After _____ hrs.
 Project Name: Long Point WTP _____ ft., After _____ hrs.
 Drilling Method: Mud Rotary _____ ft., After _____ hrs.

LOG of BORING No. B-3

DATE 1/8/16 SURFACE ELEVATION 23.2 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0				Topsoil (6 inches)	22.7					
4			SS							
8			SS	Stiff to very stiff dark brown silty CLAY, trace sand		2.50				
5		P	P			1.50	24.0	26	21	M T C
7			SS			2.75-3.0				
12			SS			3.0-4.0	17.1	26	16	M
10			SS	- very stiff to hard						
					9.7					
15			SS	Loose to medium dense light gray silty coarse to fine SAND			21.8			
20			SS				14.6	NP	NP	M
25			SS							
30			SS	- becoming coarse to fine sand with gravel, trace silt						
35			SS	- loose to medium dense gray and reddish brown clayey medium to fine sand			33.9	32	14	M
40			SS			1.50				

(Stratum 2)

(Continued on Sheet 2 of 2)

Completion Depth: 50.0 ft. Water Depth: See ft., After _____ hrs.
 Project No.: 60436481 Notes ft., After _____ hrs.
 Project Name: Long Point WTP _____ ft., After _____ hrs.
 Drilling Method: Mud Rotary _____ ft., After _____ hrs.

8/5/16 BORLOGR 80436481 LONG POINT WTP.GPJ

LOG of BORING No. B-3

DATE 1/8/16 SURFACE ELEVATION 23.2 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45		19	SS	Medium dense dark gray coarse to fine SAND, trace silt			20.6			M
50		40	SS	(Stratum 2)	-26.8					
55				Notes: 1. Samples were observed to be wet at a depth of approximately 15 feet during drilling.						
60										
65										
70										
75										
80										
85										

8/5/16 BORLOGR 80436481 - LONG POINT WTP.GPJ

Completion Depth: 50.0 ft. Water Depth: See ft., After _____ hrs.
 Project No.: 60436481 Notes ft., After _____ hrs.
 Project Name: Long Point WTP _____ ft., After _____ hrs.
 Drilling Method: Mud Rotary _____ ft., After _____ hrs.

LOG of BORING No. B-4

DATE 1/8/16 SURFACE ELEVATION 23.1 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0				Topsoil (2 inches)	22.9					
		9	SS	Medium dense to dense brown silty medium to fine SAND	21.1					
6			SS	Stiff to very stiff brown silty CLAY, trace fine sand		1.25				
5		4	SS							
8		8	SS							
8		8	SS		- very stiff to hard					
10					12.1	1.0- 1.25 3.0- 4.5				
		19	SS	Loose to medium dense gray and brown silty coarse to fine SAND, trace gravel						
15										
		4	SS	- becoming light gray						
20										
		4	SS							
25										
		5	SS							
30										
		11	SS	- coarse to fine sand and gravel, trace silt						
35										
		6	SS	- becoming loose silty coarse to fine sand						
40										
		2	SS							

(Stratum 2)

(Continued on Sheet 2 of 2)

Completion Depth: 50.0 ft. Water Depth: See ft., After _____ hrs.
 Project No.: 60436481 Notes ft., After _____ hrs.
 Project Name: Long Point WTP _____ ft., After _____ hrs.
 Drilling Method: Mud Rotary _____ ft., After _____ hrs.

8/5/16 BORLOGR 80436481 LONG POINT WTP.GPJ

LOG of BORING No. B-4

DATE 1/8/16 SURFACE ELEVATION 23.1 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45		10	SS	Loose to medium dense dark gray silty coarse to fine SAND, trace fine gravel (Stratum 2)						
50		29	SS		-26.9					
55				Notes: 1. Samples were observed to be wet at a depth of approximately 15 feet during drilling on 1/8/16 and groundwater was recorded at 15 feet on 1/11/16.						
60										
65										
70										
75										
80										
85										

8/5/16 BORLOGR 80436481 LONG POINT WTP.GPJ

Completion Depth: 50.0 ft. Water Depth: See ft., After _____ hrs.
 Project No.: 60436481 Notes ft., After _____ hrs.
 Project Name: Long Point WTP _____ ft., After _____ hrs.
 Drilling Method: Mud Rotary _____ ft., After _____ hrs.

LOG of TEST PIT No. INF-001

DATE 2/4/2016 SURFACE ELEVATION 22.5 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	DESCRIPTION	STRATUM ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0		Topsoil (Approximately 18 inches)	21.0				
		Brown SILT					
5		- with medium to fine sand		26.1			M
		(Stratum 2)					
			15.5				M
10		Notes: 1. The test pit was dry during excavation. 2. Double Ring Infiltration (DRI) test was performed at a depth of 5 ft below ground surface.					
15							

Completion Depth: 7.0 ft. Water Depth: See ft., After _____ hrs.
 Project No.: 60436481 Notes ft., After _____ hrs.
 Project Name: Long Point WTP _____ ft., After _____ hrs.

8/5/16 TPO085.60436481 - LONG POINT WTP.GPJ



LOG of TEST PIT No. INF-002

DATE 2/4/2016 SURFACE ELEVATION 23.2 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	DESCRIPTION	STRATUM ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0		Topsoil (Approximately 18 inches)	21.7				
5		- with medium to fine sand (Stratum 2)		26.2			M
10			16.2				M
15		Notes: 1. The test pit was dry during excavation. 2. Double Ring Infiltration (DRI) test was performed at a depth of 5 ft below ground surface.					

8/5/16 TPO085.60436481 - LONG POINT WTP.GPJ

Completion Depth: 7.0 ft. Water Depth: See ft., After _____ hrs.
 Project No.: 60436481 Notes ft., After _____ hrs.
 Project Name: Long Point WTP _____ ft., After _____ hrs.



Appendix B
Laboratory Testing

Physical property tests were conducted in the laboratory on selected representative soil samples to aid in classification and for correlation with engineering behavior of the soils. These tests included natural water content (ASTM D 2216), grain-size distribution (ASTM D 422), liquid and plastic limits (ASTM D 4318), and unconfined compressive strength of rock (ASTM D 7012). Engineering property tests were conducted in the laboratory on relatively undisturbed Shelby tube samples. These tests included unconsolidated-undrained (UU) triaxial compression (ASTM D 2850) and consolidation (ASTM D 2435).

The numerical results are summarized on Page B-2 and are also shown on the appropriate boring logs. Grain-size distribution curves are presented on Pages B-3 through B-6. UU triaxial test results are presented on Page B-7, and consolidation test results are shown on Pages B-8 through B-14.

Project: Long Point WTP
Project No.: 60436481



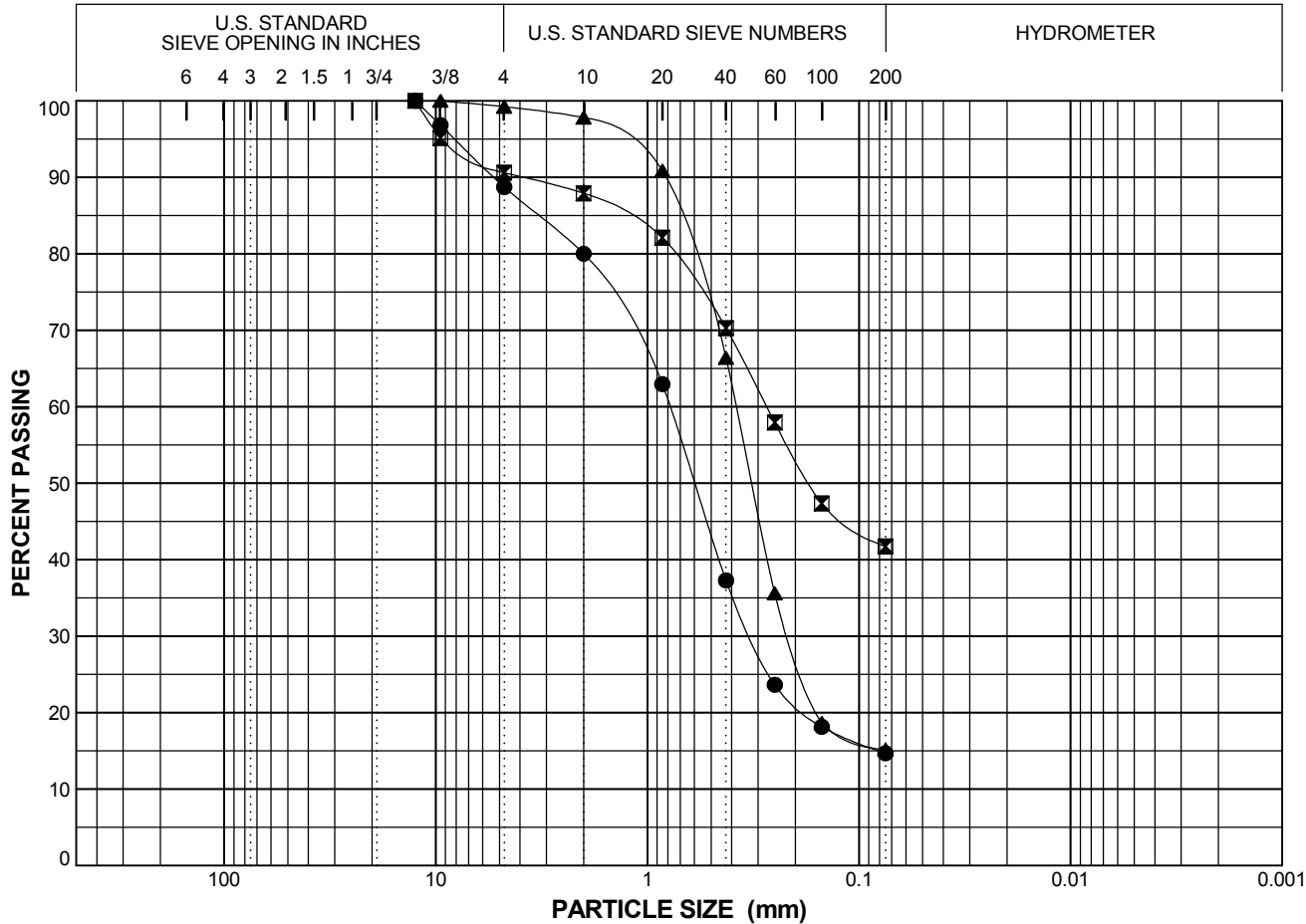
SUMMARY OF LABORATORY TEST RESULTS

Boring and Sample Number	Depth (feet)	Classification	USCS Symbol	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits		Specific Gravity	Organic Content (%)	Grain Size		Compaction	Consolidation	Unconfined Compression		Triaxial Compression		Permeability (cm/sec)	Special Tests
						Liquid Limit	Plastic Limit			<#200 (%)	<2µ (%)			Stress (psi)	Strain (%)	UU	CIU		
B-1 S-4	6.0-8.0	Light brown SILTY SAND	SM	8.5						15									
B-1 S-6	10.0-12.0	Gray CLAYEY SAND	SC	13.6		31	15			42									
B-1 S-7	15.0-17.0	Gray SILTY SAND	SM	19.9						15									
B-3 ST-1	4.0-6.0	Brown SILTY CLAY	CL-ML	24.0		26	21	2.69		96	10		*			*			
B-3 S-4	8.0-10.0	Gray LEAN CLAY with SAND	CL	17.1		26	16			71									
B-3 S-6	15.0-17.0			21.8															
B-3 S-7	20.0-22.0	Light brown SILTY SAND	SM	14.6		NP	NP			12									
B-3 S-10	35.0-37.0	Light brown CLAYEY SAND	SC	33.9		32	14			35									
B-3 S-12	45.0-47.0	Gray POORLY GRADED SAND with SILT	SP-SM	20.6						8									
INF-001 S-1	5.0-5.2	Brown SILT	ML	26.1						96	12								
INF-001 S-2	7.0-7.2	Brown SILT with SAND	ML	22.4						84	12								
INF-002 S-1	5.0-5.2	Brown SILT	ML	26.2						97	15								
INF-002 S-2	7.0-7.2	Brown SILT with SAND	ML	20.3						82	10								

The soil classification and USCS symbols are based partially on visual classification unless both Atterberg limits and grain size analysis tests are performed.

* Refer to Laboratory Test Curves

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	



SYMBOL	●	☒	▲
Boring	B-1	B-1	B-1
Sample	S-4	S-6	S-7
Spec			
Depth (in)	6.0-8.0	10.0-12.0	15.0-17.0
% +3"	0.0	0.0	0.0
% Gravel	11.3	9.4	0.8
% Sand	74.1	48.9	84.1
% Fines	14.7	41.7	15.2
% -2μ			
Cc			
Cu			
LL		31	
PL		15	
PI		16	
USCS	SM	SC	SM
w (%)	8.5	13.6	19.9

Particle Size (Sieve #)	PERCENT FINER		
	●	☒	▲
2"			
1 1/2"			
1"			
3/4"			
1/2"	100.0	100.0	100.0
3/8"	96.8	95.2	100.0
4	88.7	90.6	99.2
10	80.0	87.9	97.8
20	62.9	82.1	90.8
40	37.3	70.3	66.4
60	23.6	57.9	35.6
100	18.1	47.4	18.7
200	14.7	41.7	15.2

SYMBOL	DESCRIPTION AND REMARKS
●	Light brown SILTY SAND (SM)
☒	Gray CLAYEY SAND (SC)
▲	Gray SILTY SAND (SM)

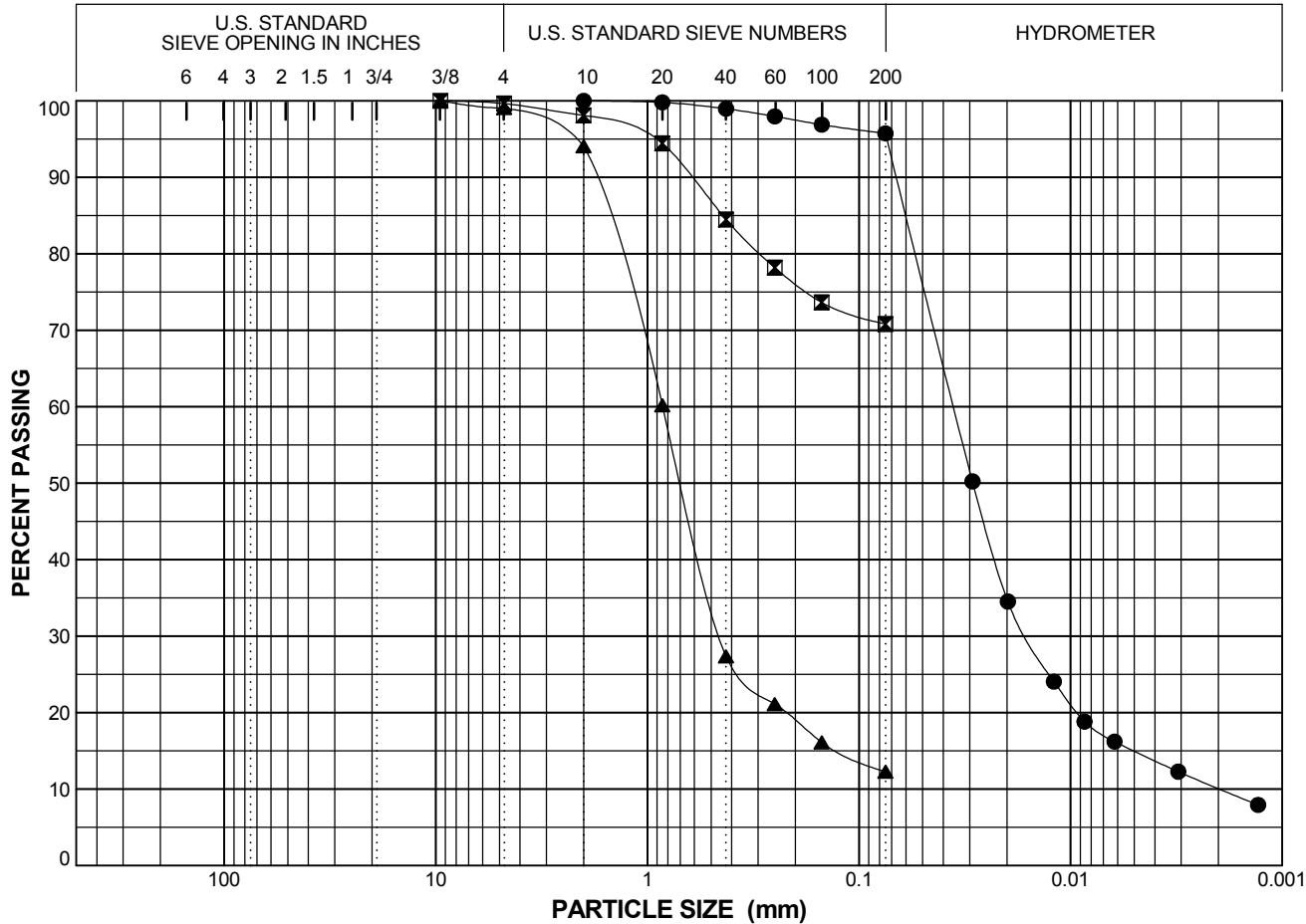
PARTICLE SIZE DISTRIBUTION
Long Point WTP

Project Number 60436481	April, 2016
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SIEVE_BLUEBELL_NEW_60436481_LONG POINT WTP.GPJ_URS_BLUE.GDT 4/26/16

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	



SYMBOL	●	☒	▲
Boring	B-3	B-3	B-3
Sample	ST-1	S-4	S-7
Spec			
Depth (in)	4.0-6.0	8.0-10.0	20.0-22.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.4	0.9
% Sand	4.3	28.8	86.8
% Fines	95.7	70.8	12.3
% -2 μ	10.1		
Cc	3.62		4.79
Cu	18.12		17.02
LL	26	26	NP
PL	21	16	NP
PI	5	10	NP
USCS	CL-ML	CL	SM
w (%)	24.0	17.1	14.6

Particle Size (Sieve #)	PERCENT FINER		
	●	☒	▲
2"			
1 1/2"			
1"			
3/4"			
1/2"			
3/8"		100.0	100.0
4		99.6	99.1
10	100.0	98.1	94.0
20	99.8	94.4	60.2
40	99.0	84.5	27.4
60	98.0	78.2	21.1
100	96.9	73.6	16.1
200	95.7	70.8	12.3

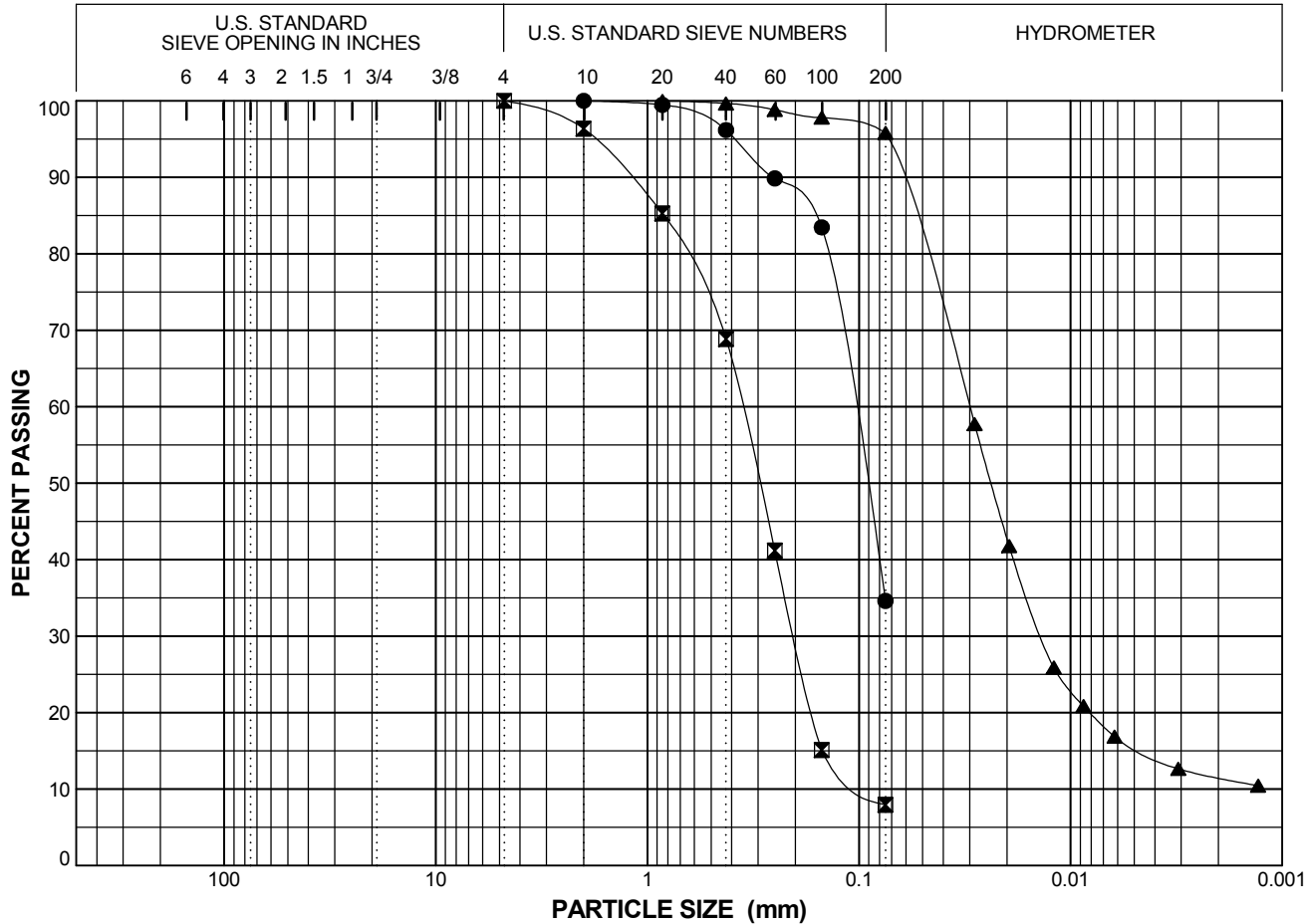
SYMBOL	DESCRIPTION AND REMARKS
●	Brown SILTY CLAY (CL-ML)
☒	Gray LEAN CLAY with SAND (CL)
▲	Light brown SILTY SAND (SM)

PARTICLE SIZE DISTRIBUTION
Long Point WTP

Project Number 60436481	April, 2016
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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	



SYMBOL	●	☒	▲
Boring	B-3	B-3	INF-
Sample	S-10	S-12	001
Spec			S-1
Depth (in)	35.0-37.0	45.0-47.0	5.0-5.2
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% Sand	65.4	92.1	4.2
% Fines	34.6	7.9	95.8
% -2 μ			11.5
Cc		1.23	
Cu		3.91	
LL	32		
PL	14		
PI	18		
USCS	SC	SP-SM	ML
w (%)	33.9	20.6	26.1

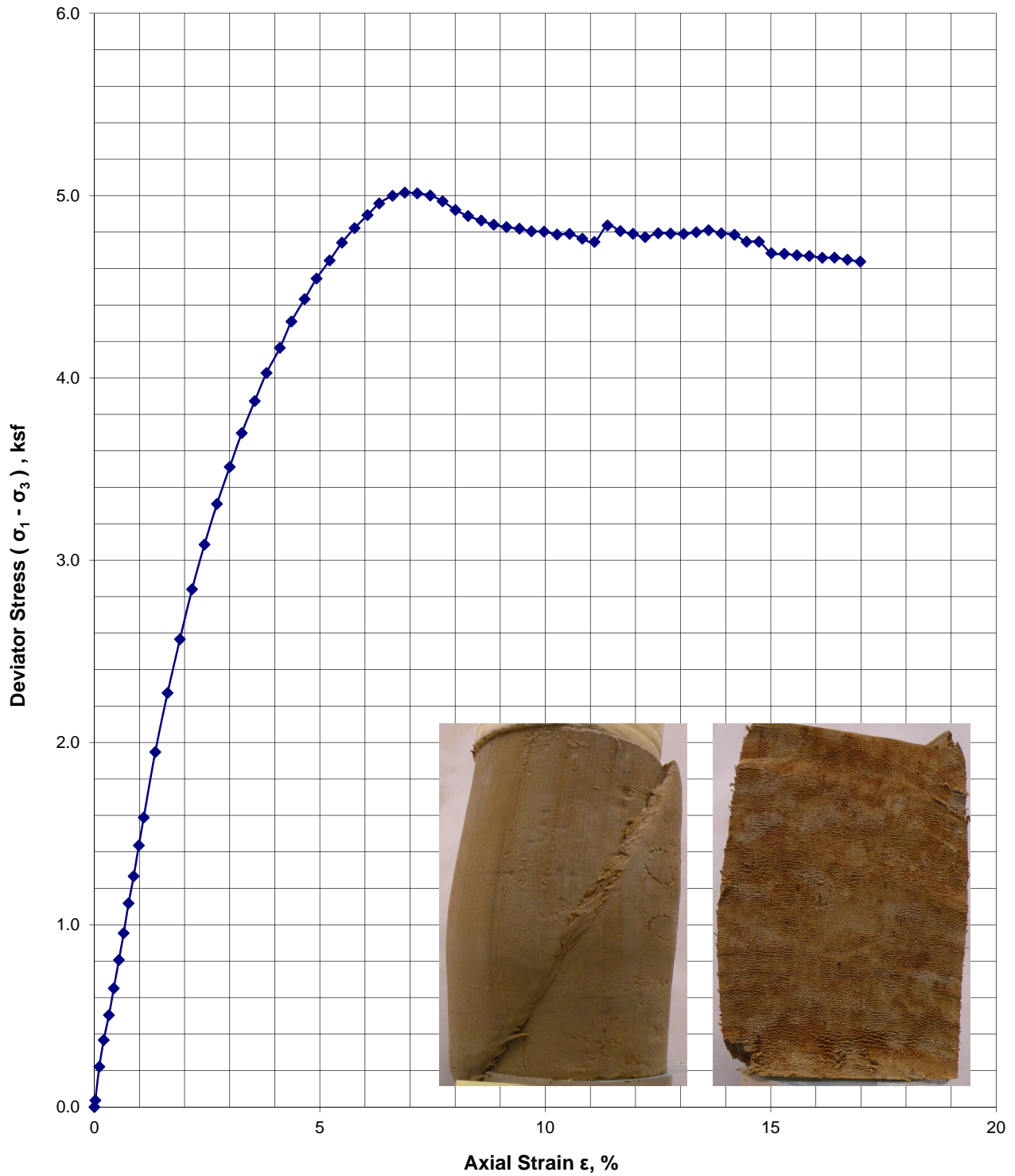
Particle Size (Sieve #)	PERCENT FINER		
	●	☒	▲
2"			
1 1/2"			
1"			
3/4"			
1/2"			
3/8"			
4		100.0	
10	100.0	96.4	
20	99.5	85.3	100.0
40	96.2	68.9	99.7
60	89.9	41.2	98.8
100	83.5	15.1	97.8
200	34.6	7.9	95.8

SYMBOL	DESCRIPTION AND REMARKS
●	Light brown CLAYEY SAND (SC)
☒	Gray POORLY GRADED SAND with SILT (SP-SM)
▲	Brown SILT (ML)

PARTICLE SIZE DISTRIBUTION
Long Point WTP

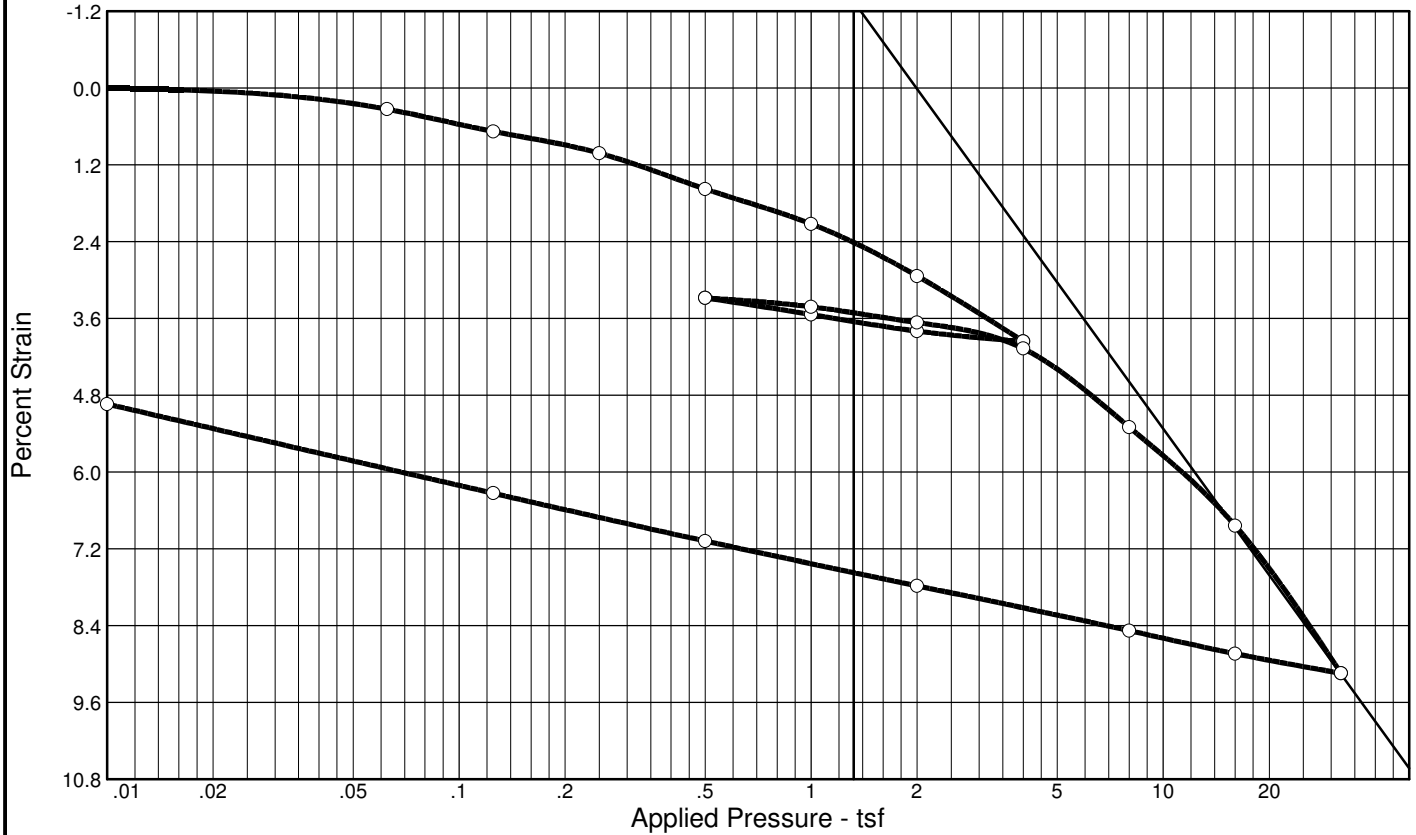
Project Number 60436481	April, 2016
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AECOM



Specimen Information					Test Summary					
Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Atterberg Limits		Initial Length (in)	Initial Dia. (in)	σ_3 (ksf)	$(\sigma_1 - \sigma_3)_{max}$ (ksf)	ϵ_f %	Strain Rate (%/min)
23.8	125.6	101.4	LL	PL	5.86	2.88	0.72	5.02	6.88	1.0
26	21	Brown SILTY CALY				Tested by: TV		Reviewed by: MHD		
Project No.: 60436481		Project Name: Long Point WTP			Unconsolidated-Undrained Triaxial Compression (UU) Test ASTM D 2850					
Boring No.: B-3		Sample No.: ST-1			Sample Depth (ft): 4.5-5.0		Date: 1/20/2016			

CONSOLIDATION TEST REPORT



Coefficients of Consolidation and Secondary Consolidation

No.	Load (tsf)	C_v (ft. ² /day)	C_α	No.	Load (tsf)	C_v (ft. ² /day)	C_α	No.	Load (tsf)	C_v (ft. ² /day)	C_α
1	0.06	2.81	0.000	11	1.00	3.23	0.001	21	0.13	4.07	0.002
2	0.13	2.14		12	2.00	0.37		22	0.01	0.52	
3	0.25	3.88		13	4.00	1.75					
4	0.50	1.05		14	8.00	0.84					
5	1.00	2.03		15	16.00	2.12					
6	2.00	3.61		16	32.00	5.84					
7	4.00	0.81		17	16.00	5.65					
8	2.00	12.49		18	8.00	10.89					
9	1.00	9.65		19	2.00	10.77					
10	0.50	9.71		20	0.50	4.10					

Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Swell Press. (tsf)	Swell %	e_0
Sat.	Moist.											
101.1 %	21.4 %	107.0	26	5	2.69		5.29	0.12	0.02			0.570

MATERIAL DESCRIPTION	USCS	AASHTO
Brown SILTY CLAY	CL-ML	

Project No. 60436481 Project: Long Point WTP Source: B-3	Client: AECOM Conshohocken Sample No.: ST-1 Elev./Depth: 5.0-5.3	Remarks: The coefficient of secondary compression values are strain based.
URS CORPORATION Fort Washington, PA		

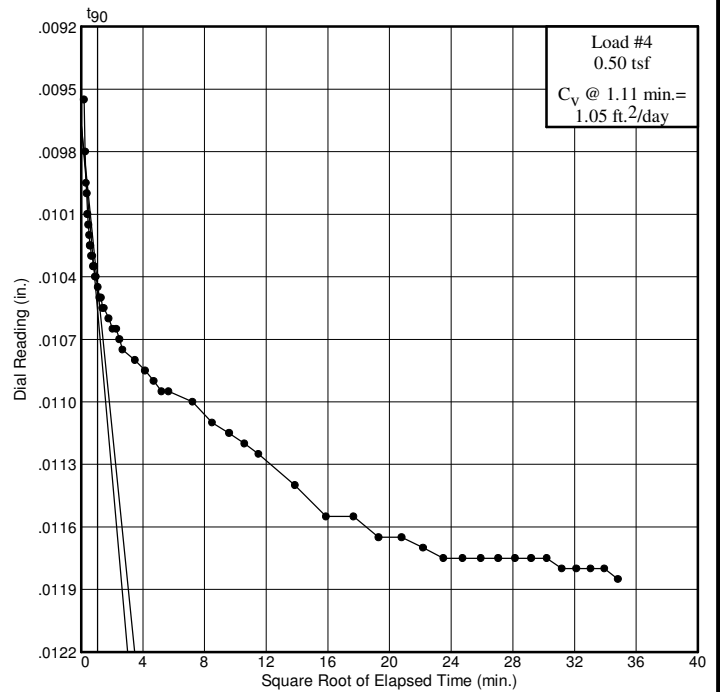
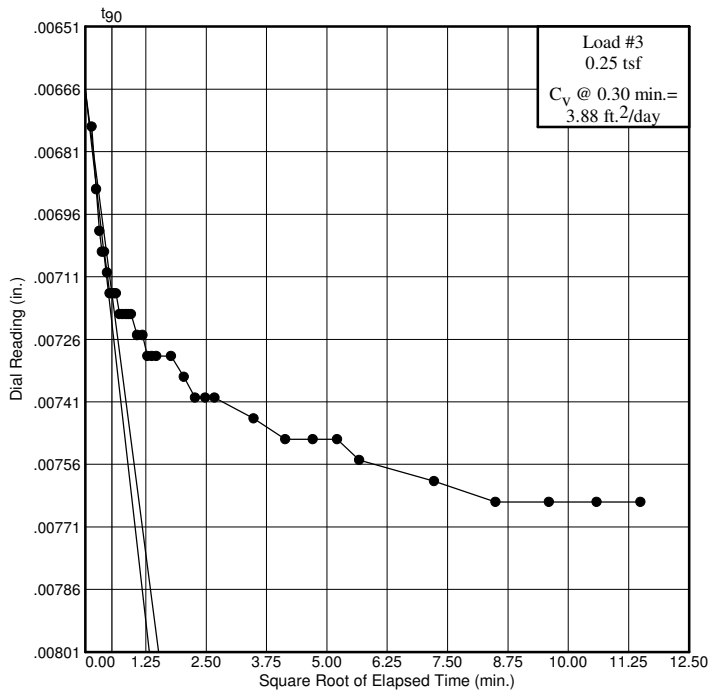
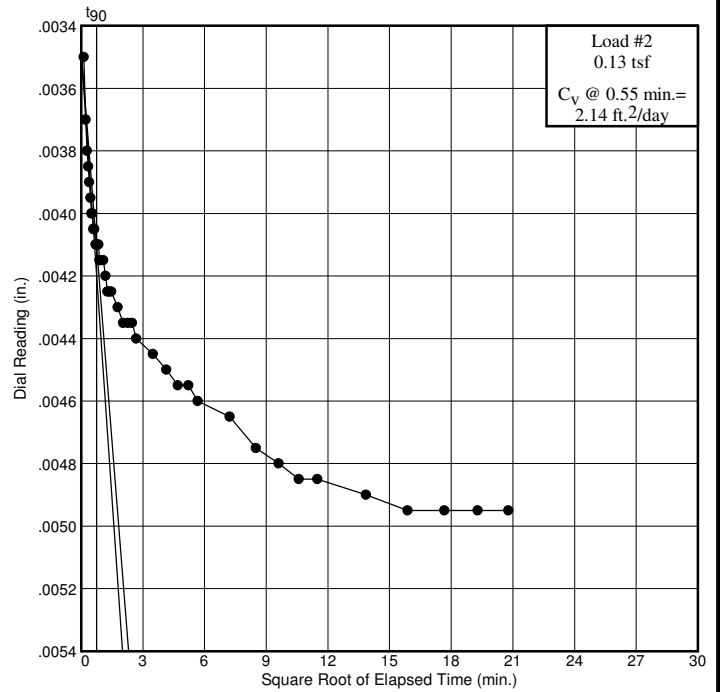
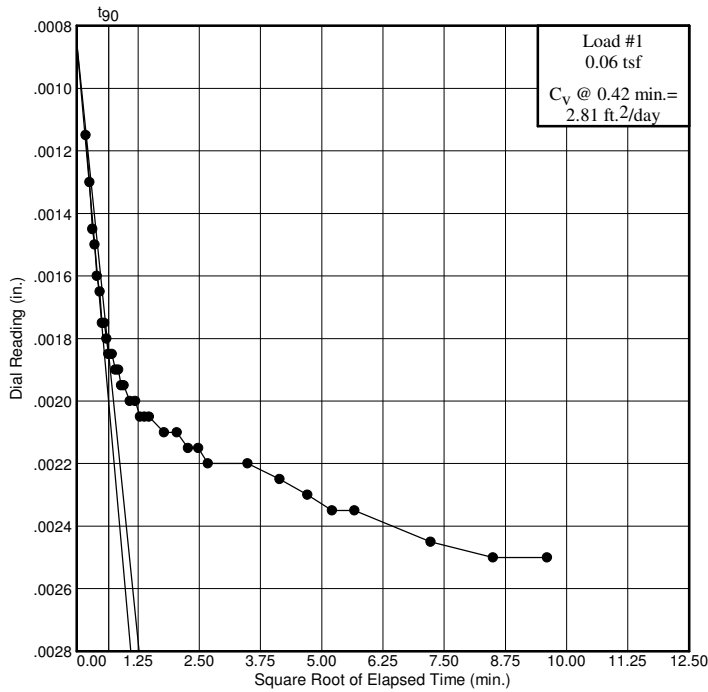
Dial Reading vs. Time

Project No.: 60436481
 Project: Long Point WWTP

Source: B-3

Sample No.: ST-1

Elev./Depth: 5.0-5.3



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 Fort Washington, PA

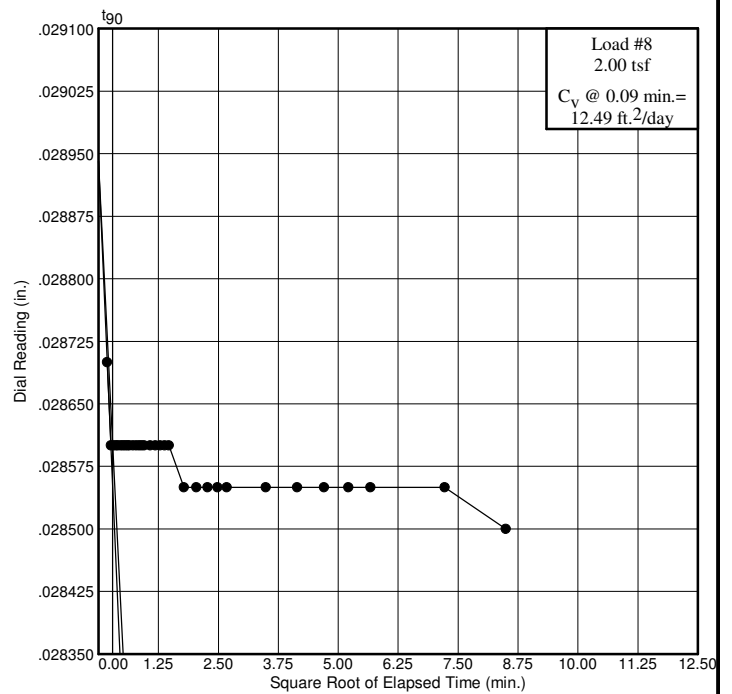
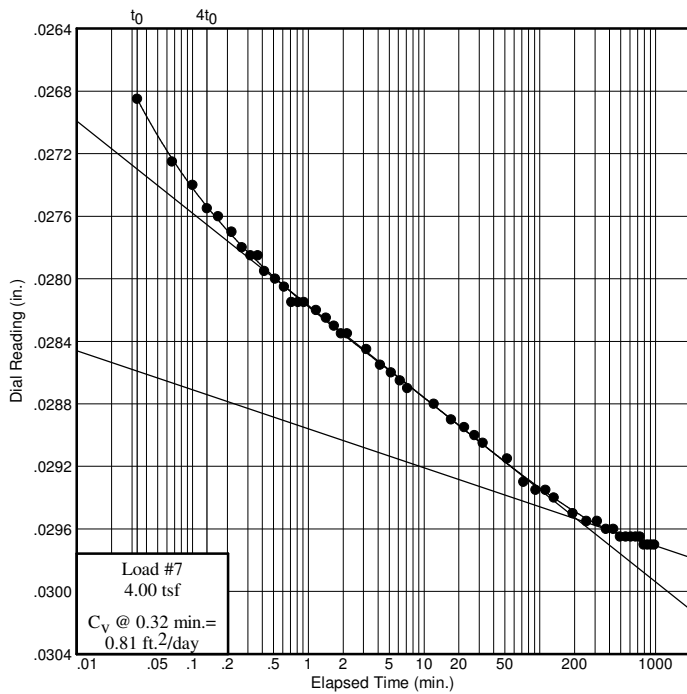
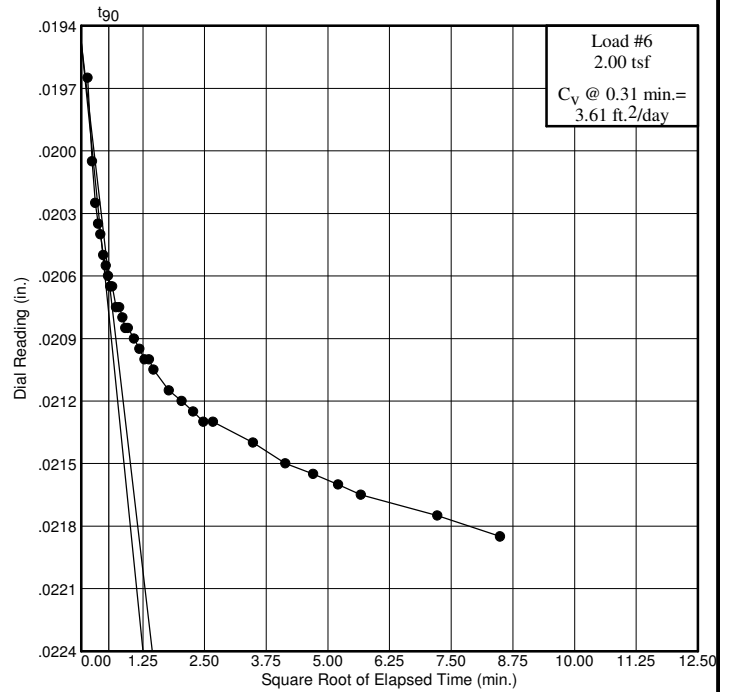
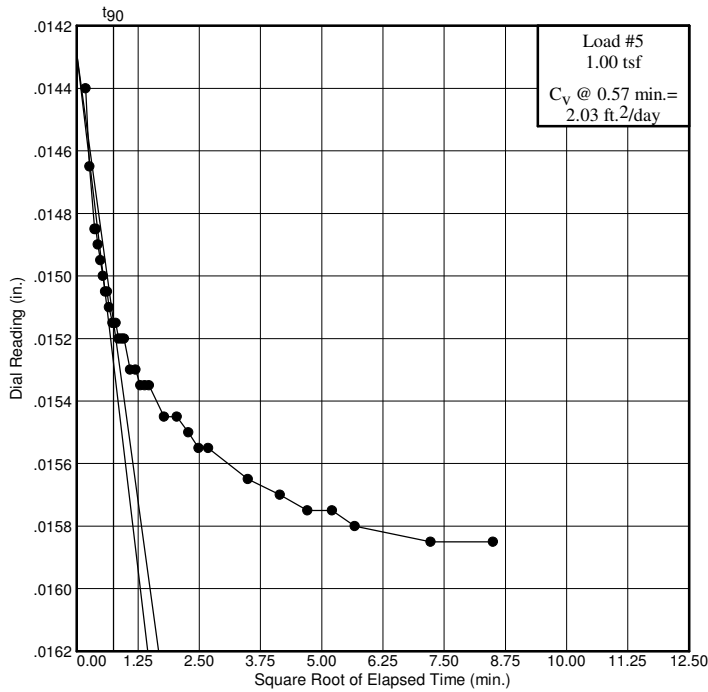
Dial Reading vs. Time

Project No.: 60436481
 Project: Long Point WWTP

Source: B-3

Sample No.: ST-1

Elev./Depth: 5.0-5.3



URS CORPORATION
Fort Washington, PA

Dial Reading vs. Time

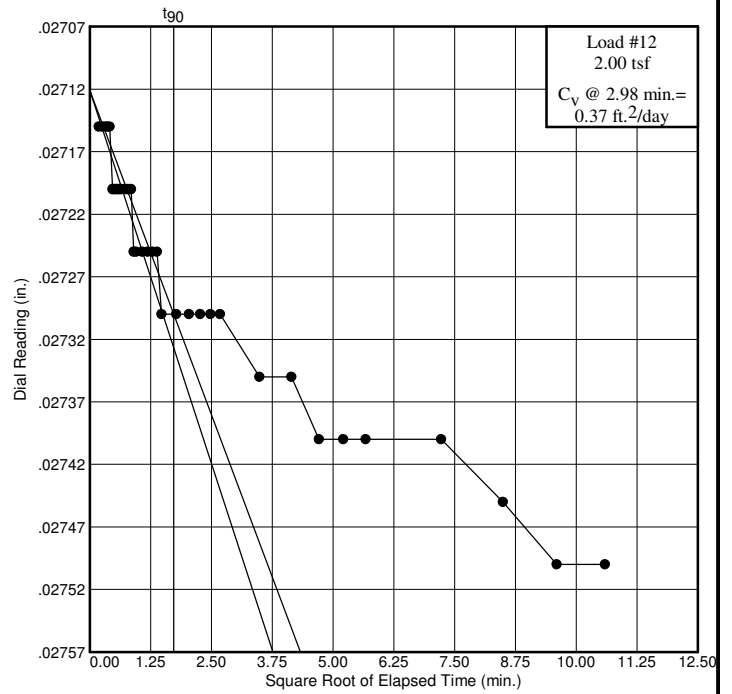
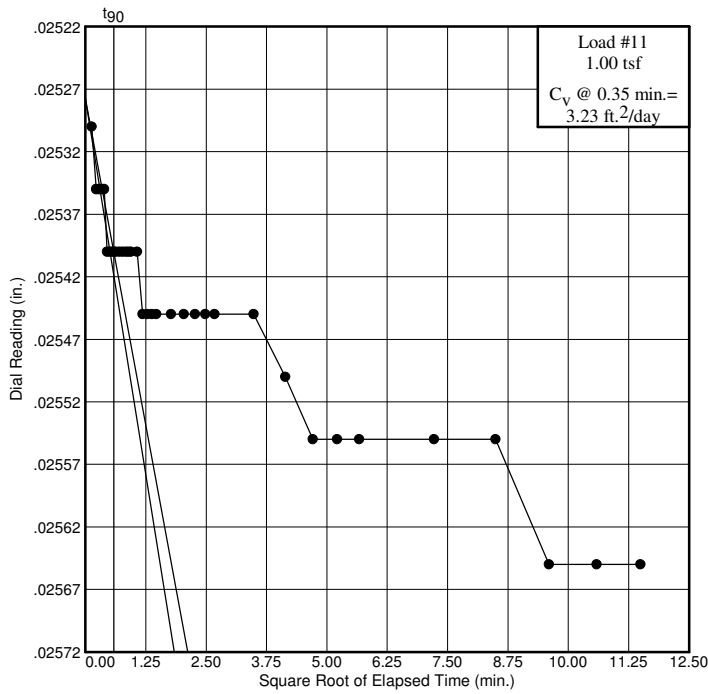
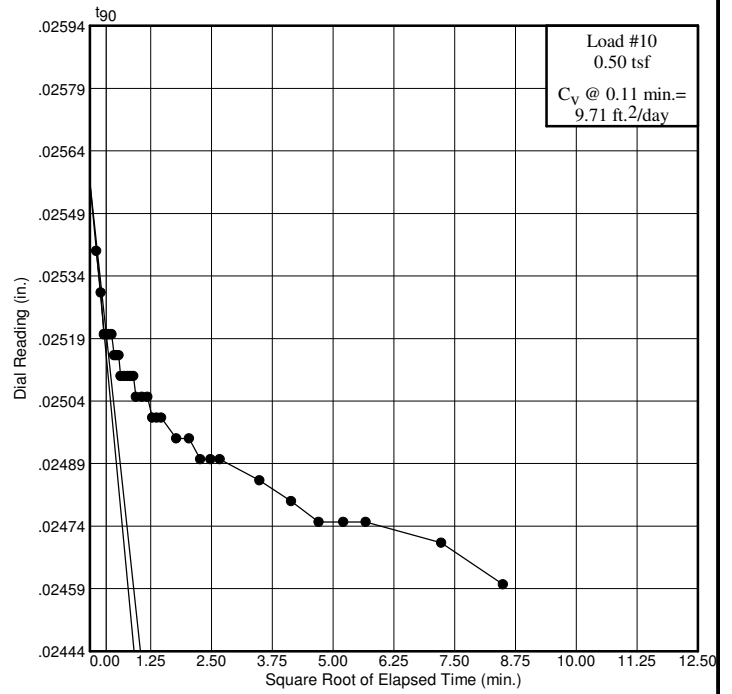
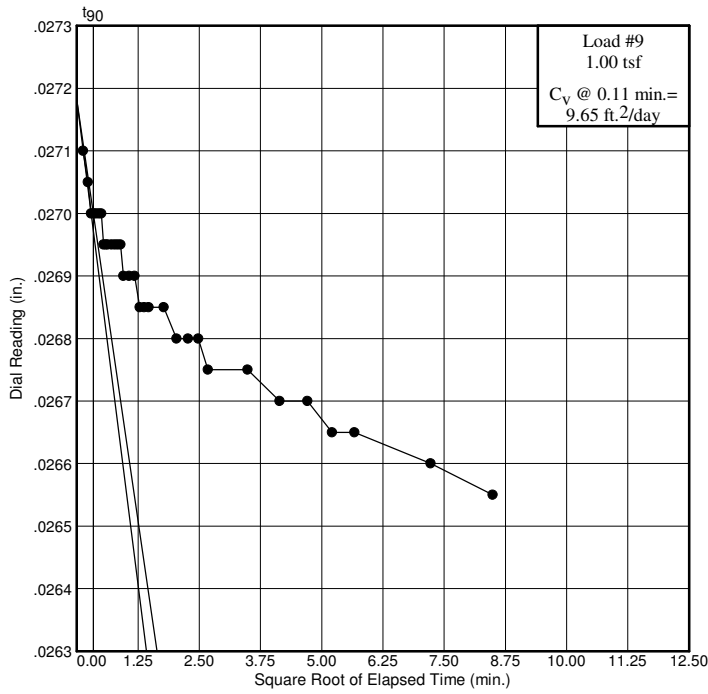
Project No.: 60436481

Project: Long Point WWTP

Source: B-3

Sample No.: ST-1

Elev./Depth: 5.0-5.3



URS CORPORATION
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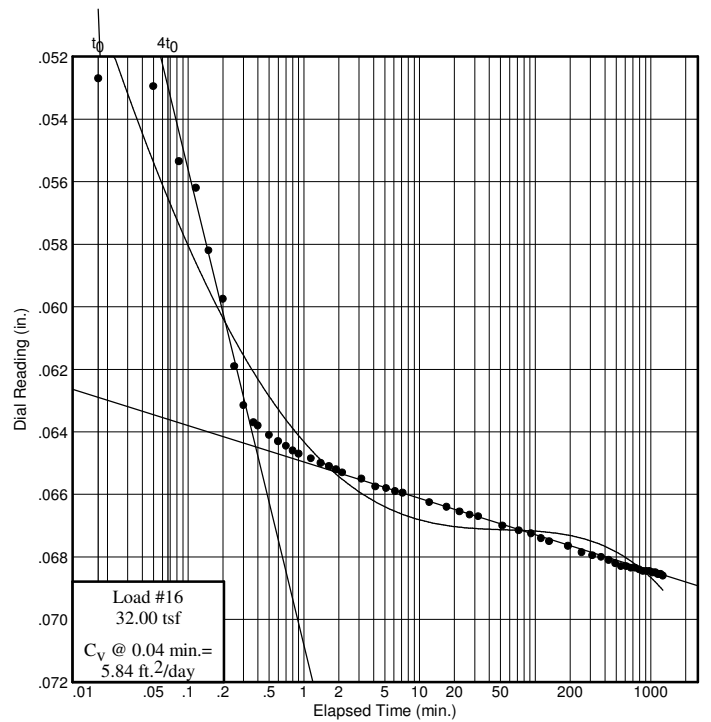
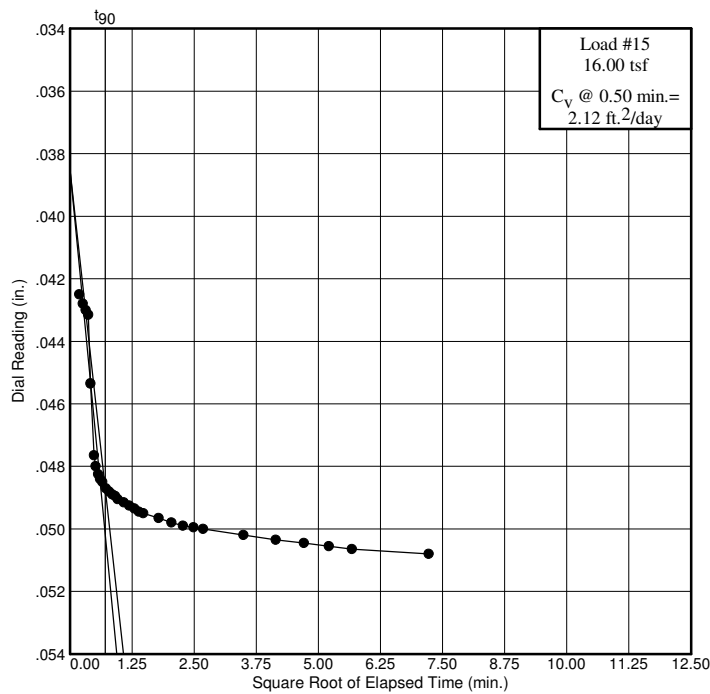
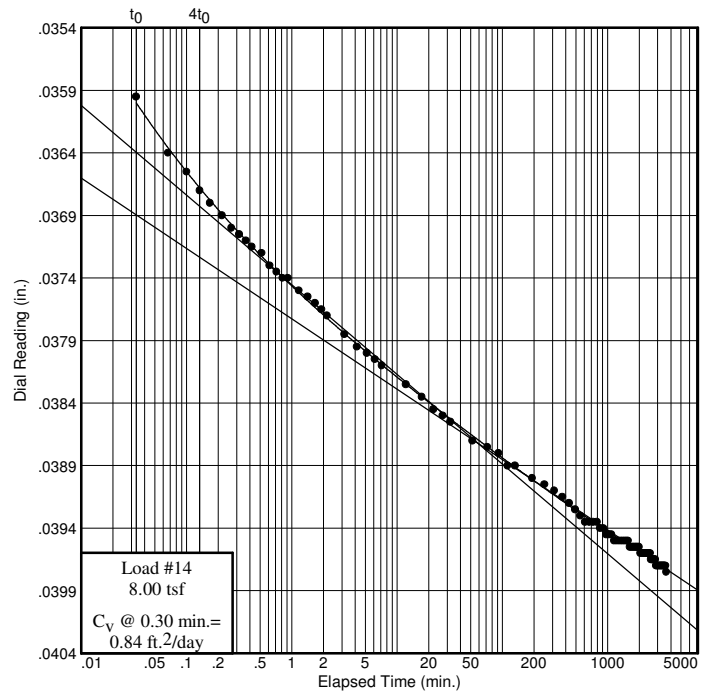
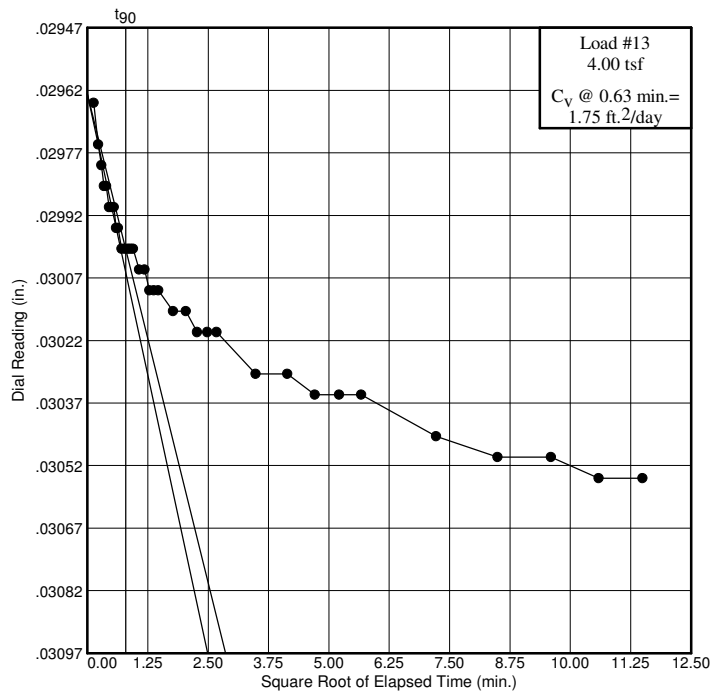
Dial Reading vs. Time

Project No.: 60436481
 Project: Long Point WWTP

Source: B-3

Sample No.: ST-1

Elev./Depth: 5.0-5.3



URS CORPORATION
 Fort Washington, PA

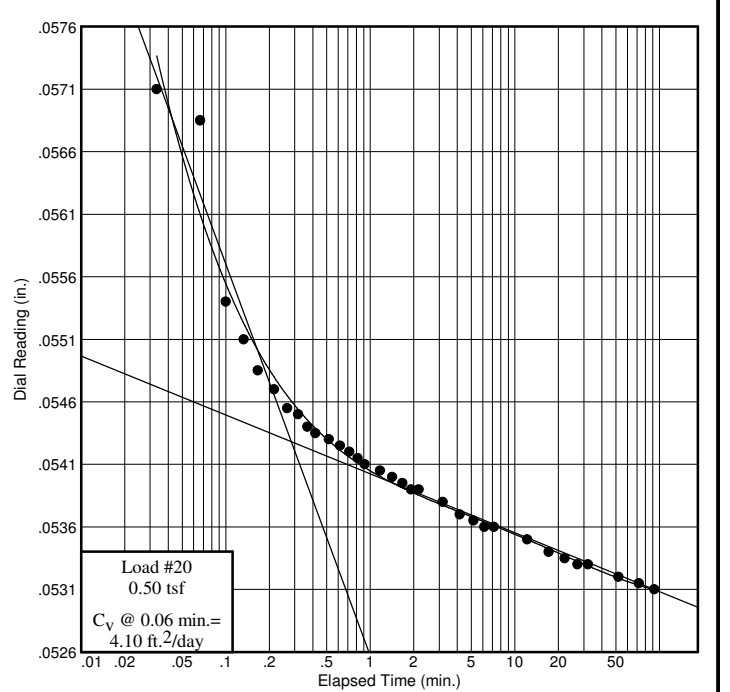
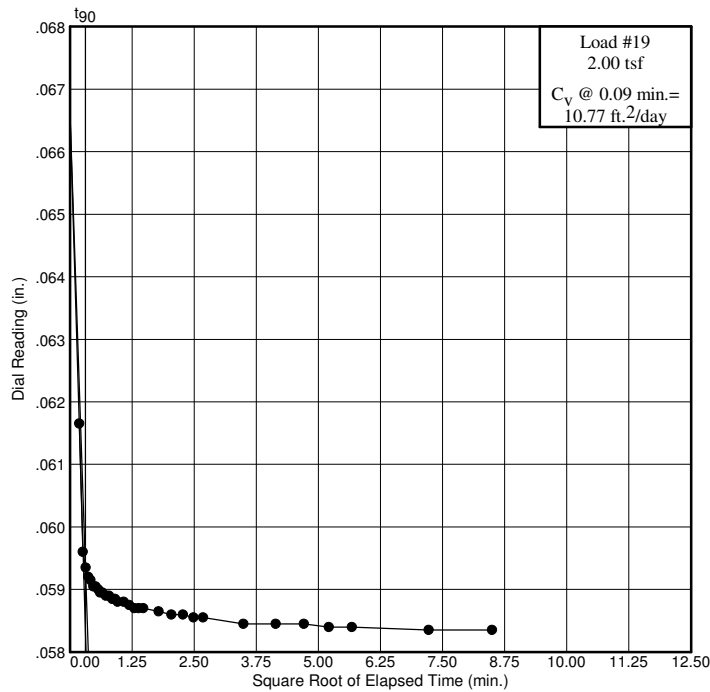
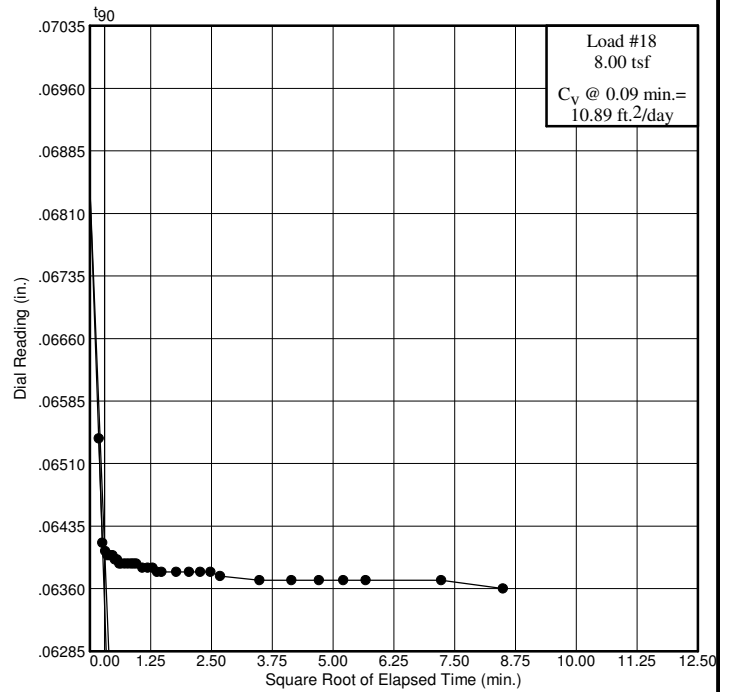
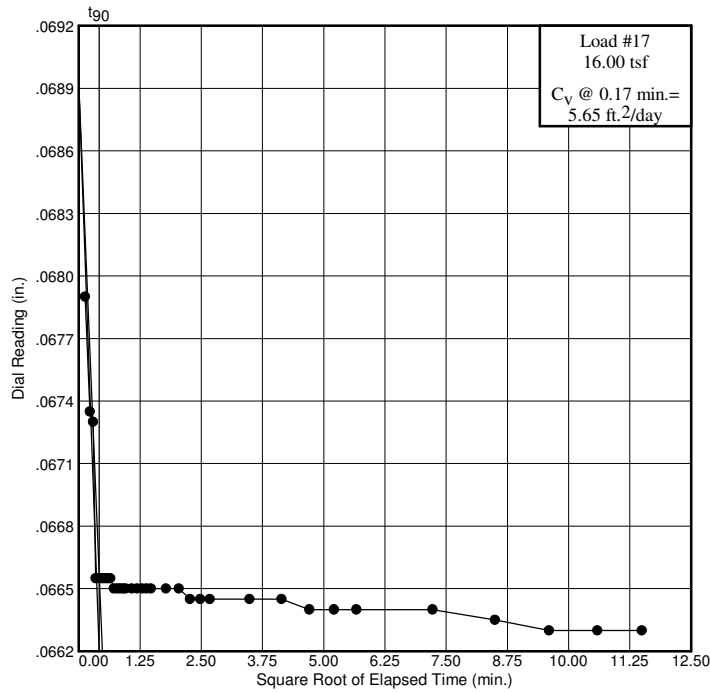
Dial Reading vs. Time

Project No.: 60436481
 Project: Long Point WWTP

Source: B-3

Sample No.: ST-1

Elev./Depth: 5.0-5.3



URS CORPORATION
Fort Washington, PA

Dial Reading vs. Time

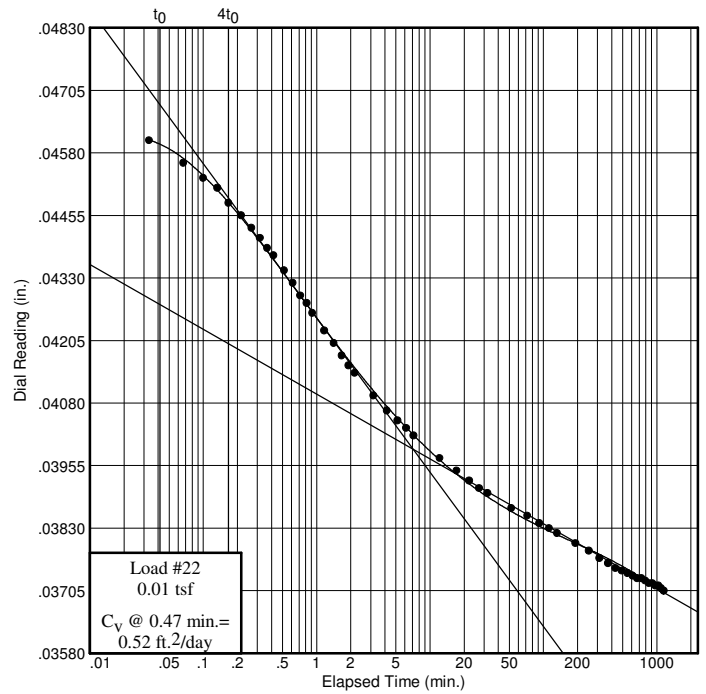
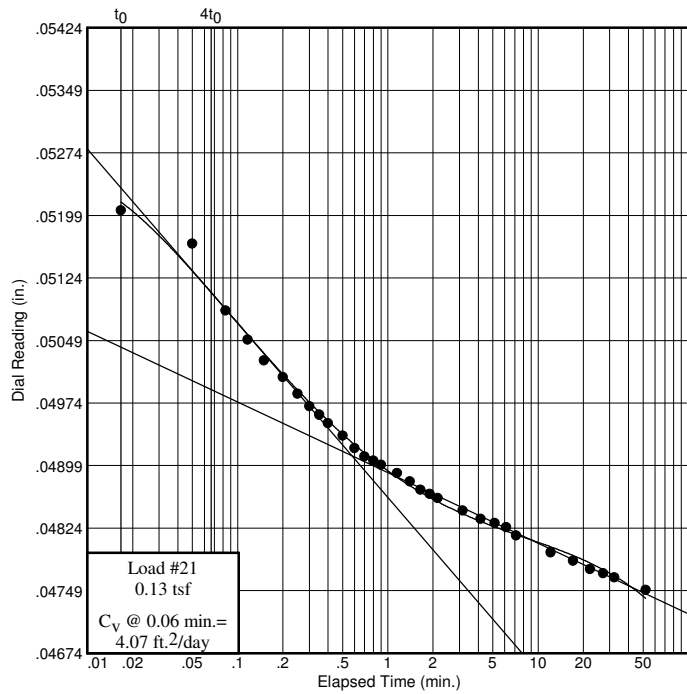
Project No.: 60436481

Project: Long Point WWTP

Source: B-3

Sample No.: ST-1

Elev./Depth: 5.0-5.3



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Appendix C
Double Ring Infiltration Tests

Two Double Ring Infiltration (DRI) tests were performed, as shown on Plate 2. Each location was excavated to approximately 5 feet below existing grade using a backhoe, where the test was performed. A second test pit was excavated next to the DRI test location to approximately 7 feet below existing grade to determine the underlying soil type.

Each DRI test setup consists of two concentric metal rings (24-inches and 12-inches in diameter). The rings were set approximately 4 to 6 inches into soil. A constant hydraulic head was maintained using a pair of calibrated Mariotte tubes. A total of two tests were performed in general accordance with the ASTM D3385.

A soil sample was collected within 6 inches from the bottom of each inner ring, where infiltration tests were performed.

The results of the DRI tests are presented on Pages C-2 through C-3.

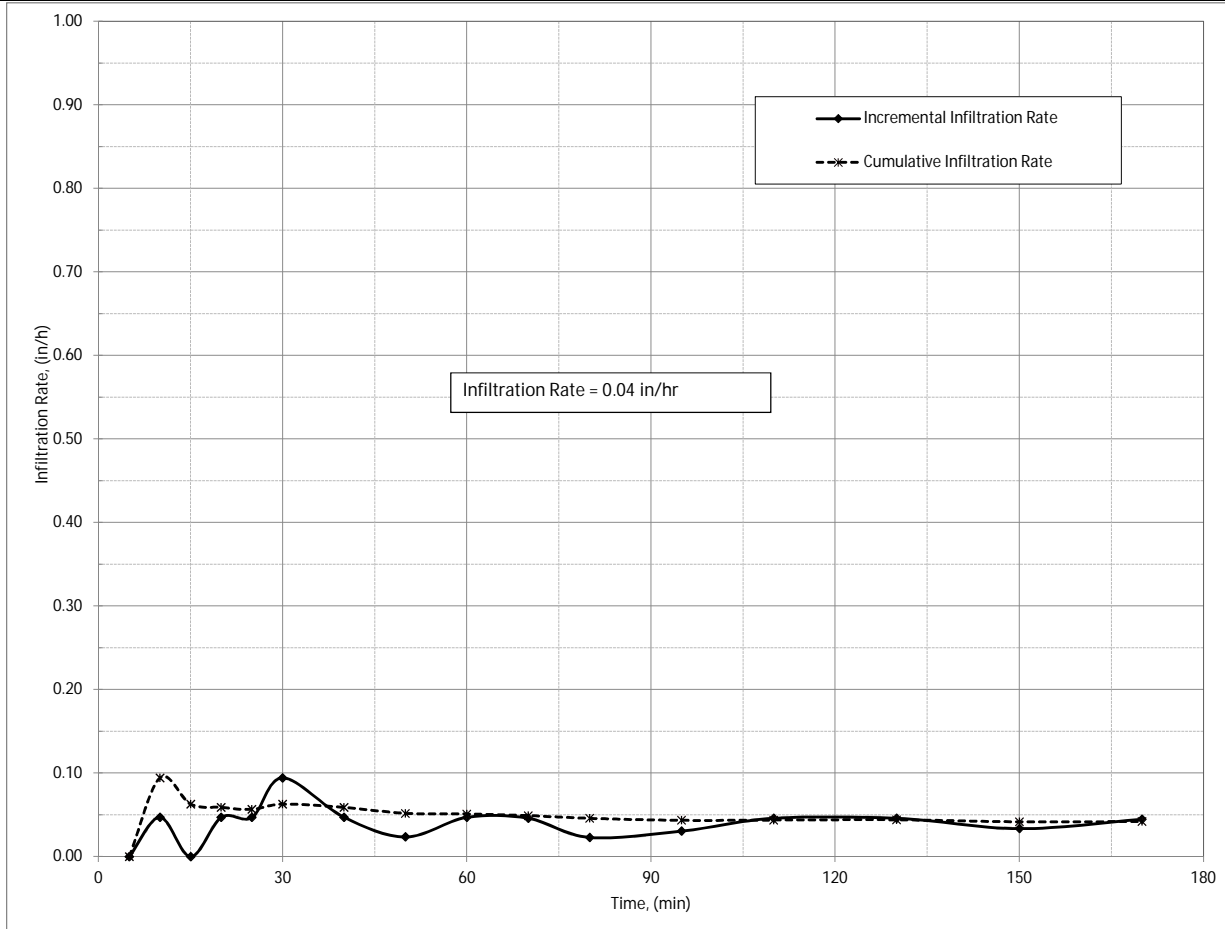
Infiltration Rate of Soil Using Double-Ring Infiltrometer - ASTM D3385

Project Name: Dover Long Point WTP
Project Number: 60434681
Location: INF-001
Depth: 5 ft (bgs)
Test Date: 02/04/16
Checked by: NS

Date: 8/5/2016

	Ring Penetration (in)	Diameter (cm)	Area (cm ²)	Depth of Liquid (cm)
Inner Ring	4	30.48	729.29	2.00
Annular Space	4	60.96	2135.92	2.00
Inner Mariotte Tube:	1cm Δh =	60.8	cm ³ (ΔV)	
Annular Mariotte Tube:	1cm Δh =	166.7	cm ³ (ΔV)	

Initial (Zero) Mariotte Tube Reading		Reading		Inner Ring Readings			Annular Space Readings			Temperature		Incremental Infiltration Rate (in/h)		Cumulative Infiltration Rate (in/h)	
Inner Ring (* Reset)	Annular Space (*Reset)	Incremental Time (min)	Cumulative Time (min)	Reading (cm)	Incremental Flow (cm ³)	Cumulative Flow (cm ³)	Reading (cm)	Incremental Flow (cm ³)	Cumulative Flow (cm ³)	Reading °C	Correction Factor	Inner Ring	Annular Space	Inner Ring	Annular Space
0.3	7.4	5	5	0.3	0.0	0.0	7.4	0.0	0.0	13.2	1.20	0.00	0.00	0.00	0.00
0	0	5	10	0.4	6.1	24.3	11.2	633.5	1867.0	13.2	1.20	0.05	1.68	0.09	2.47
0	0	5	15	0.4	0.0	24.3	14.9	616.8	2483.8	13.2	1.20	0.00	1.63	0.06	2.19
0	0	5	20	0.5	6.1	30.4	18	516.8	3000.6	13.2	1.20	0.05	1.37	0.06	1.99
0	0	5	25	0.6	6.1	36.5	21.7	616.8	3617.4	13.2	1.20	0.05	1.63	0.06	1.92
0	0	5	30	0.8	12.2	48.6	28	1050.2	4667.6	13.2	1.20	0.09	2.78	0.06	2.06
0	0	10	40	1	12.2	60.8	33	833.5	5501.1	13.2	1.20	0.05	1.10	0.06	1.82
0	0	10	50	1.1	6.1	66.9	37.1	683.5	6184.6	13.2	1.20	0.02	0.90	0.05	1.64
0	0	10	60	1.3	12.2	79.0	42.4	883.5	7068.1	13.7	1.20	0.05	1.17	0.05	1.56
0	0	10	70	1.5	12.2	91.2	48	933.5	8001.6	14.3	1.17	0.05	1.20	0.05	1.47
0	0	10	80	1.6	6.1	97.3	51.5	583.5	8585.1	14.4	1.17	0.02	0.75	0.05	1.38
0	0	15	95	1.8	12.2	109.4	54.8	550.1	9135.2	14.0	1.17	0.03	0.47	0.04	1.24
0	0	15	110	2.1	18.2	127.7	58.3	583.5	9718.6	14.2	1.17	0.05	0.50	0.04	1.14
0	0	20	130	2.5	24.3	152.0	61	450.1	10168.7	14.6	1.17	0.05	0.29	0.04	1.01
0	0	20	150	2.8	18.2	170.2	64	500.1	10668.8	15.0	1.14	0.03	0.31	0.04	0.89
0	0	20	170	3.2	24.3	194.6	66.6	433.4	11102.2	15.0	1.14	0.04	0.27	0.04	0.82



Infiltration Rate of Soil Using Double-Ring Infiltrometer - ASTM D3385

Project Name: Dover Long Point WTP
Project Number: 60434681
Location: INF-002
Depth: 5 ft (bgs)
Test Date: 02/04/16
Checked by: NS

Date: 8/5/2016

	Ring Penetration (in)	Diameter (cm)	Area (cm ²)	Depth of Liquid (cm)
Inner Ring	4	30.48	729.29	2.00
Annular Space	4	60.96	2135.92	2.00
Inner Mariotte Tube:	1cm Δh =	60.8	cm ³ (ΔV)	
Annular Mariotte Tube:	1cm Δh =	166.7	cm ³ (ΔV)	

Initial (Zero) Mariotte Tube Reading		Reading		Inner Ring Readings			Annular Space Readings			Temperature		Incremental Infiltration Rate (in/h)		Cumulative Infiltration Rate (in/h)	
Inner Ring (* Reset)	Annular Space (*Reset)	Incremental Time (min)	Cumulative Time (min)	Reading (cm)	Incremental Flow (cm ³)	Cumulative Flow (cm ³)	Reading (cm)	Incremental Flow (cm ³)	Cumulative Flow (cm ³)	Reading °C	Correction Factor	Inner Ring	Annular Space	Inner Ring	Annular Space
1	2.7	5	5	1	0.0	0.0	2.7	0.0	0.0	13.2	1.20	0.00	0.00	0.00	0.00
0	0	5	10	1	0.0	60.8	2.7	0.0	450.1	13.2	1.20	0.00	0.00	0.24	0.60
0	0	5	15	2.5	91.2	152.0	2.7	0.0	450.1	13.2	1.20	0.71	0.00	0.39	0.40
0	0	5	20	2.5	0.0	152.0	2.7	0.0	450.1	13.2	1.20	0.00	0.00	0.29	0.30
0	0	5	25	2.5	0.0	152.0	3	50.0	500.1	13.2	1.20	0.00	0.13	0.24	0.26
0	0	10	35	2.5	0.0	152.0	3.5	83.4	583.5	13.2	1.20	0.00	0.11	0.17	0.22
0	0	10	45	2.5	0.0	152.0	3.5	0.0	583.5	13.2	1.20	0.00	0.00	0.13	0.17
0	0	10	55	2.5	0.0	152.0	3.7	33.3	616.8	13.2	1.20	0.00	0.04	0.11	0.15
0	0	10	65	2.5	0.0	152.0	3.7	0.0	616.8	13.7	1.20	0.00	0.00	0.09	0.13
0	0	15	80	2.5	0.0	152.0	4.5	133.4	750.2	14.3	1.17	0.00	0.11	0.07	0.12
0	0	15	95	3	30.4	182.4	5.2	116.7	866.8	14.4	1.17	0.08	0.10	0.07	0.12
0	0	15	110	3	0.0	182.4	5.4	33.3	900.2	14.0	1.17	0.00	0.03	0.06	0.11
0	0	15	125	3.1	6.1	188.5	6	100.0	1000.2	14.2	1.17	0.02	0.09	0.06	0.10
0	0	20	145	3.3	12.2	200.6	6.8	133.4	1133.6	14.6	1.17	0.02	0.09	0.05	0.10
0	0	20	165	3.8	30.4	231.0	8	200.0	1333.6	15.0	1.14	0.06	0.13	0.05	0.10
0	0	20	185	4	12.2	243.2	8.7	116.7	1450.3	15.0	1.14	0.02	0.07	0.05	0.10

